SCIENTIFIC AMERICAN SUPPLEMENT. No 1410

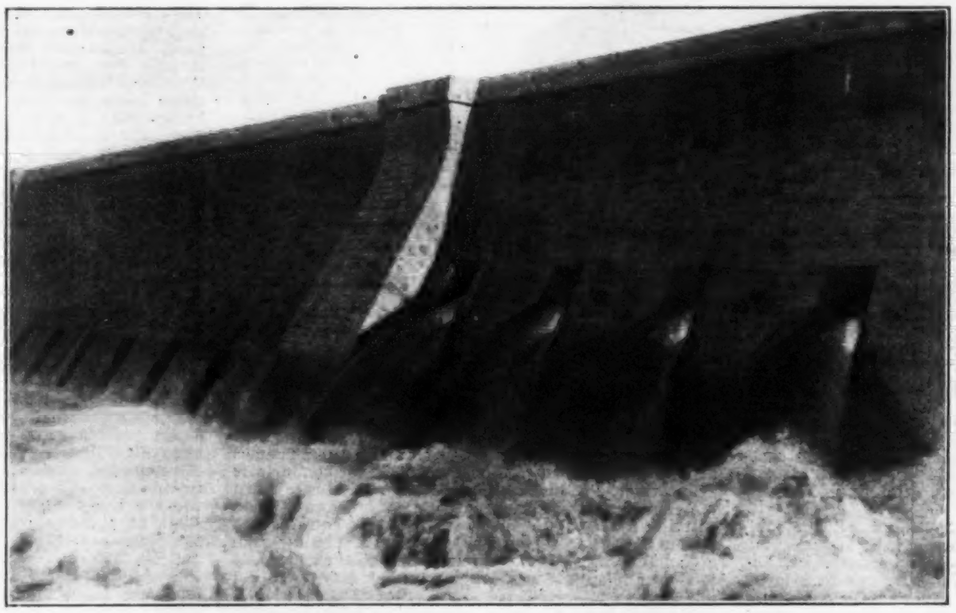
Scientific American, established 1845.
Scientific American Supplement, Vol. LV. No. 1410.

NEW YORK, JANUARY 10, 1903.

Scientific American Supplement. $5 a year.
Scientific American and Supplement. $7 a year.

THE OPENING OF THE ASSOUAN DAM.

When the *laudator temporis acti* wants to silence the engineer, he says: "After all, Egypt can show the biggest engineering works in the world, and they are all four thousand years old. When you can surpass them, you will have something to boast of." It is undoubtedly true that Egypt contains the largest structures in the world, and probably will for all time. It is not likely that we shall again see a building with seven million tons of stone in it, as has the pyramid of Gizeh, and it will be long before we have an irrigation reservoir of greater capacity than Lake Moeris, which, accepting the figures of Major Sir R. H. Brown, R.E., held 11,800 million cubic meters (tons) of water between high and low water marks. What the Labyrinth was like we do not really know, but Herodotus classed it as a greater wonder than the Pyramids, although lesser than Lake Moeris. We may safely assume that there is now nothing in the world that will compare with it in size. Further, there is a tradition that in the dim past the Nile flowed at the foot of the Libyan hills, and that it was diverted from that course into its present bed, and, if the account be true, the work was of enormous magnitude. Measured by the standard of the quantity surveyor, the works of the ancient Egyptians have never been surpassed, and probably never will be. The engineers of the past directed the forces of Nature on a large scale; but to compare their work with ours to their advantage shows a complete ignorance of the science of engineering. The matter in which they excelled was the transportation and manipulation of heavy weights—a feat that appeals strongly to the lay imagination. Among the chief examples of such work are the columns of the temple of Karnak. To cut a block of stone in a distant quarry, work it to a cylinder 12 feet in diameter, float it down the Nile, land it, and place it on the top of a column of similar stones, making a total height of 60 feet, was no small enterprise. A still more difficult undertaking was the great obelisk now standing beside the Church of St. John Lateran in Rome, with a height of 108 feet and a weight of 450 tons. But the crowning example of Egyptian engineering was the colossal statue of Rameses II., at Thebes. Before it was broken, it was a single block of red granite 60 feet in height, and it has been computed to weigh 887 tons. These were notable examples of engineering work, and a modern engineer might be proud of executing them. But it must be remembered that they were done very leisurely, and that labor was



THE WATER RUSHING THROUGH THE SLUICE GATES.

THE GREAT NILE DAM AT ASSOUAN, RECENTLY OPENED.

THE OPENING OF THE GREAT DAM AT ASSOUAN.

abundant. With the simple appliances that we may assume the Egyptians possessed, such as wedges, levers, ropes, and pulleys, great weights may be handled if time is no object. The city of Thebes was in course of building for 2,000 years, and in such a place it would excite little comment if a year was spent in putting an obelisk into position. If a weight can be moved at all, no matter how little, it can be transported any distance, provided the same conditions persist for the whole route. The Romans moved two obelisks from Thebes, and re-erected them at Alexandria; showing conclusively that the Egyptians had no secrets in relation to mechanics, and that their methods could be imitated by a practical people with perfect success. Their strong point was the abundance of cheap labor.

Under the conditions of flood irrigation the land of Egypt is like a dry brickfield during half the year, except in such places as where water can be obtained from wells and canals; and consequently the peasants can, under a despotic government, be sent to labor upon public works without serious injury to the community. The system endured from the dawn of history until some ten years ago, and the fellaheen never showed symptoms of dying out.

PHARAOH'S BED, WHICH HAS BEEN FORTIFIED AGAINST THE ACTION OF WATER.

The irrigation works of Egypt show evidences of more varied engineering skill than do the monuments; but there is nothing in them that is difficult of explanation when we remember that the country had enjoyed some 2,000 years of civilization before the more important were executed. How long has our own country displayed a material civilization equal to that in Egypt in the year 2000 B. C.? Certainly not 200 years; possibly not 100. If the Egyptians had only possessed coal and iron, they would have left very little for the nineteenth century to discover. They were denied the aid of steam, but they could command armies of laborers, and consequently no work was too vast for them, provided that not any portion was beyond the strength of a hundred or a thousand hands. The digging of a canal that would pass as much water as the Thames was quite possible, while they were adepts at masonry for gates and regulating works. Owing to the annual rise and fall of the Nile, it was seldom that such work could be executed in the dry.

But a few weeks have passed since there was opened in Egypt a new work, which would have been absolutely impossible of execution by the builders of the pyramids, because it would not have been feasible to supply the necessary labor for keeping the water out of the foundations. Within the restricted area of one of the river channels they could not have crowded sufficient men to remove the water that leaked in, and hence the ground could not have been kept dry. Further, the matter was one that did not allow of leisurely treatment. The foaming torrent was always tearing and thrusting at the obstacles which were thrown in to check its progress; and it was only by piling them in faster than it could remove them that its velocity could be checked. It carried away 5-ton blocks like pebbles; and in one instance it was necessary to fling in a whole train of heavily-laden wagons, elaborately tied together with wire-rope, to form a breakwater to check its rush, and create an abutment for the thousands of tons that followed. Each section of foundation had to be completed before the annual flood, to prevent its subsequent destruction; and throughout the operations time was one of the chief elements of the problem. The ancient Egyptians might as well have essayed to spin a rope of sand as to dam the Nile at Assouan, for each minute would have seen the work of its predecessor fall to pieces and be lost. Messrs. Aird & Co. had 13,000 men on the job, and the Pharaohs could not have crowded many more on the spot. They could have handled the stones and have built the wall in the dry, but the water would have been too much for them. As Sir Benjamin Baker has said, "It never sleeps, but day and night is stealthily seeking to defeat your plans." The engineer who would contend against it needs to do more in a day than it can do in a day and a night, and to accomplish this he must call to his aid a mightier force than human muscle.

At the spot where the dam was built, 600 miles above Cairo, the Nile is 1¼ miles wide during flood, but during the winter it is divided into five channels with intervening islands. It must not be supposed that it contracts to mere rills, for at its lowest it carries five or six times as much water as the Thames at mean annual flood, so that each of its channels is a fine river. The current runs at headlong rate down the Assouan Cataract, the speed in one channel being 15 miles an hour and the depth 30 feet. The fall is 3 meters in 200 meters. The difficulty of closing such a channel was enormous, even with the other channels left open as spillways. The tale has already been told in Engineering (see vol. lxix., page 318, March 9, 1900), but is worth briefly recounting. Sir Benjamin Baker and Messrs. Aird, after much deliberation, determined to obtain still water on the site of the foundation in each channel by building a rubble dam below it, thus creating a flat gradient above the dam. As already related, this was effected by pouring into the river stone blocks varying from 1 ton to 12 tons in weight. Many of them disappeared, but train-load after train-load was hurried up and tipped, and gradually the mound crept out from either bank until a junction was effected in the middle. Three of these dams were built the first year, and were left for the high Nile to flow over them. When the river fell, other dams, locally known as "sudds," were built of sand-bags above the site of the foundation, while the lower dam was tightened by the same means. There was thus inclosed a pond of still water, and the question was, "Could it be pumped dry?" The bed was below the level of the river 30 feet or 40 feet, and it was known, or fairly conjectured, that the rock was overlaid by large bowlders, and was possibly traversed by fissures communicating freely with the river above. Twenty-four 12-inch centrifugal pumps were provided to deal, if necessary, with one channel. There was every reason to fear that springs would spurt up all over the area, and it was by no means certain that some of them might not be beyond the power of any pumping plant to deal with. If that had been so, these fissures would have had to be plugged under water, an undertaking of great difficulty and entailing enormous expense. It was an anxious moment when the pumping commenced, but it was not long before it was realized that Nature had been kind to the contractors. The Nile silt had so nearly closed every opening that two 12-inch pumps sufficed to keep the site clear.

The site of the Assouan dam was chosen by Sir W. Willcocks, after prolonged investigation of the river bed at various places. The position offers an extensive outcrop of syenite and quartz diorite, clean across the valley of the Nile. There was neither time nor opportunity to make borings in the rock, and when the contractors got to work they found it was not as good as was expected. In many places it was unsound, with schistous micaceous masses of a very friable nature, which necessitated carrying down the foundations of the dam more than 40 feet deeper than was originally provided for in the contract. As the thickness of the dam is nearly 100 feet at the base, this involved a large increase in the contract quantity and cost of the granite masonry, the total amount of which was about 1,000,000 tons.

At this period it is scarcely necessary, when so much has been written on the subject, to give a detailed account of the dam, and we will confine ourselves to very brief particulars. It is a straight masonry wall, closing the passage of the Nile from shore to shore. Its length is 2,000 meters; the maximum height from foundation, 130 feet; the extreme difference of water level above and below being 67 feet. The up-stream face is perpendicular, or nearly so, while that on the down-stream side is battered to reduce the width on the top to 7 meters. When full, the reservoir behind the dam will hold 1,065 million cubic meters of water. As Sir Benjamin Baker explained in his lecture before the Royal Institution of Great Britain last June, this quantity of water would furnish one year's domestic supply to every city, town, and village in the United Kingdom. It is also about equal to the annual rainfall on a circle drawn with a 13-mile radius around Charing Cross. The 1,000 million tons of water is only a small part of what the land of Egypt could utilize during the three or four months of summer. During these months the flow from the reservoir will be equivalent to a river double the size of the Thames in mean annual flood condition. There are several irrigation canals in Egypt which require nearly twice the summer flow of the Thames in June, if they can get it. Sooner or later the storage of water must be increased for Egypt. It could be doubled by carrying up the dam another 25 feet, but that would involve the submergence of the temple of Philæ. Lake Tsana, in Abyssinia, could store 6,000 million tons behind a dam 3 meters high, while Lakes Victoria and Albert could also be made to hold immense quantities behind dams of small height.

The first thought that arises in connection with a dam across such a river as the Nile is that the reservoir will silt up; and there have been engineers of reputation who have boldly prophesied such a result in this case. Of course, the danger was foreseen, and was provided for by arranging that the flow of the river shall be through openings in the wall. There are 140 sluice-gates 23 feet high by 6 feet 6 inches wide, and 40 gates 11 feet 6 inches by 6 feet 6 inches. Of these, 130 are on the Stoney principle, and can be moved by hand under a pressure of 450 tons. During the flood period, when the water is silt-laden, all the gates will be open, and the river will roar through the openings. After the flood, when the discharge has fallen to about 2,000 tons per second, the gates without rollers will be closed, and then some of those with rollers. Between December and March the reservoir will be gradually filled, the surplus running through the upper sluices. The reopening of the sluices will take place between May and July, according to the state of the Nile and the requirements of the crops.

It is of no advantage to have water merely flowing through the Nile bed in summer. Where it is wanted is in the irrigation canals that traverse the country up to the confines of the desert, and pass through the limestone range into the Fayoum. To enable the water to be discharged into the Great Ibrahimiyah Canal, a barrage has been built across the river at Assiut, to back up the water and divert it into the canals. This structure is similar in principle to that built at the head of the delta by French engineers many years ago. The total length is 2,750 feet, and it includes 111 arched openings of 16 feet 4 inches span, capable of being closed by steel sluice gates 16 feet in height. The piers and arches are founded on a platform of masonry 87 feet wide and 10 feet thick, protected up and down by a continuous and impermeable line of cast-iron grooved and tongued sheet piling with cemented joints. This piling extends into the sand bed of the river to a depth of 23 feet below the upper surface of the floor, and this cuts off the water and prevents the undermining action which caused so much trouble and expense in the case of the old barrage. The height of the roadway above the floor is 41 feet, and the length of the piers up and down stream 51 feet. The river bed is protected against erosion for a width of 67 feet up-stream by stone

PART OF THE RUINS OF THE ISLAND OF PHILAE

PART OF THE PYLON OF THE TEMPLE OF ISIS AT PHILAE.

pitching, with clay puddle underneath to check infiltration, and down-stream for a similar width with stone pitching with an inverted filter-bed underneath, so that any springs which may arise from the head of water above the sluices shall not carry sand with them from underneath the pitching. The method of working was to inclose the site of the proposed season's work by temporary dams in November, then to pump out and keep the water down by powerful centrifugal pumps, crowd on the men, excavate, drive the cast-iron sheet piling, build the masonry platform, lay the aprons of puddle and pitching, and get the work some height above low Nile level before the end of June, so that the temporary dams should not need reconstruction after being swept away by the flood. The busiest months, according to Sir Benjamin Baker, were May and June, when in 1900 the average daily number of men was 13,000. To keep the water down, seventeen 12-inch centrifugal pumps, throwing enough water for the supply of a city of two million inhabitants, had to be kept going, and in a single season as many as 1½ million sandbags were used in the temporary dams. A thousand springs burst up through the sand, each one of which required special treatment. It is these difficulties of construction which show us how far we have advanced beyond the engineering of the ancient Egyptians. They accomplished wonders when time fought on their side. Sir Benjamin Baker and Messrs. Aird had time as their most strenuous antagonist, and it was only by the aid of most powerful appliances that they were able to defeat it.

The Assouan Dam has been constructed in four years. In 1898 some preliminary work was done, and surveys were carried out. The foundation stone was laid by H. R. H. the Duke of Connaught on February 12, 1899. During that year excavation was completed over almost one-half of the total length of the dam, and embankments were formed on three out of the five channels. The low summer level of 1900 made it possible to excavate and lay the foundation masonry of all except the western channel, down which the whole discharge of the Nile was sent. After the flood of that year had passed, masonry work was continued, and preparations were made for damming the western channel, the only portion in which the foundation masonry was not laid by the end of 1900. Over 3,000 tons of masonry were sometimes completed in a day, and as much as 45,000 cubic meters of masonry were laid during the month just before the flood came down. The western channel was dammed in 1901, and the foundations got in before the flood. When it came this channel and the central channel were the only portions submerged. After the flood had diminished in October, the masonry was rapidly pushed forward. Since the beginning of 1902 the works have been practically completed; the dam was finished a year before contract time. The first cataract now no longer exists as a bar to navigation. A navigation canal has been constructed round it, about 2,000 meters in length, with a ladder of four locks, each 70 meters long and 9½ meters wide. There are five lock-gates, 32 feet wide, and varying in height up to 60 feet. They are of a different type to ordinary folding lock-gates, being hung from the top on rollers, and moving like a sliding coach-house door. A channel 20 meters wide was cut through the narrow rapids north and south of the dam to improve the channel for boats.

For the above account we are indebted to London Engineering; for the illustrations to the London Illustrated News and Black and White. Additional views and information will be found in the SCIENTIFIC AMERICAN for September 20, 1902.

URBAN TRANSPORTATION IN NEW YORK.

THE problem of urban transportation in New York—a problem of prime interest to millions of people—is summed up in an article by Gustav Kobbé in Pearson's:

"The Rapid Transit tunnel is being built because the elevated railroads and the surface lines have proved inadequate to handle the passenger traffic of the city. During a year the Metropolitan Street Railway system carried in round numbers (independent of the Third Avenue system) 425,000,000 passengers. The day of the Dewey parade, September 29, 1899, this railway system carried 1,304,385 people. The crush in the elevated and surface cars during the hours when people are going to and coming from business is notorious. It cannot be obviated. Trains and cars are now run on as little headway as possible. But could their number be duplicated, they would be just as crowded. New York actually grows faster than the rate at which city travel can be improved. The Rapid Transit tunnel will be finished. The elevated trains and surface cars will be as crowded as they are now, and as for the tunnel, it soon will prove as inadequate as the present means. People still will be hanging on to straps. When New York stops growing—which it never will—the Rapid Transit problem, the greatest which confronts the city, will be solved. For the sake of emphasis, let me repeat what I have said—that New York is growing faster than adequate accommodations and transportation for the city travel can be devised.

"Remember this is the same city which in 1626 Peter Minuit bought for $24; which in 1653 had 1,120 population; in 1731, 8,256; in 1800, 60,489; to find itself, in 1850, harboring 515,547; and to become, in 1900, as Greater New York, the second city of the world, with a population of 3,437,202. Only London, with its four and a half million inhabitants, surpasses New York."

WELDLESS CHAINS.

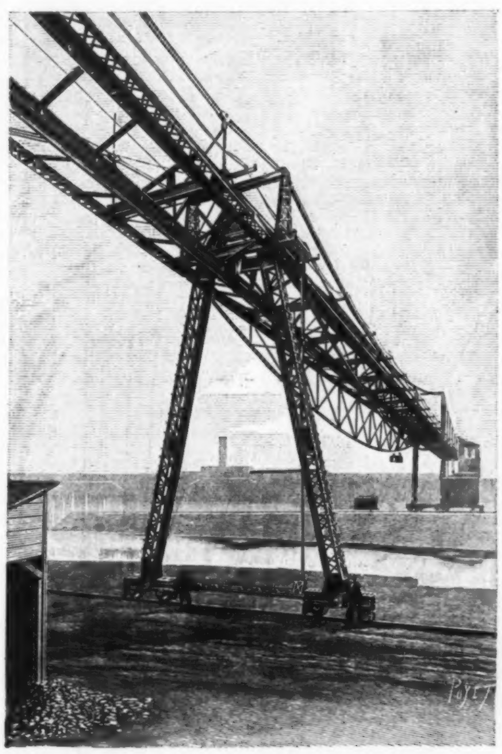
AT the recent annual meeting of the Cleveland Institute of Engineers, A. G. Strathern read a paper on weldless chains. In the course of his paper the author remarked that there appeared to have been chains of some description ever since the world began.

He had it, however, on the authority of the Shipping World, that the first iron chain cable in this country was made by Robert Flinn, of North Shields, in the year 1808, and sent on board the "Ann and Isabella," built at Berwick-on-Tweed. It would thus seem that ordinary iron chains had only been made commercially during the last century. It was acknowledged that the weak spot in chains was the weld in each link. The first record which they had of a proposal to make chains without welds came from an American named Sleppy, who obtained a patent in the United States in the year 1853. In 1881 another British patent was communicated from abroad by Eugene Oury, of France. In 1883 there was a communication from abroad by Comtess de Montabello, of France. Next came a patent granted in the United States in 1886 to Maximilian Jocker. That invention did not prove very successful, and nothing was now heard of it. Two years later a patent was granted to Julius Kinder, of Brooklyn city, for a process of weldless chain working; but a much more practical invention was that of M. Rougier, a French engineer, who obtained British patents. Another system for which a patent was granted in the year 1892 was to Herr Otto Klatte, a German engineer. That method of producing weldless chains closely resembled that of Sleppy and of Jocker. The speaker then went on to describe his own process, which, he remarked was the result of a close study of the subject and considerable experience gained in the manufacture of weldless steel chains by the Rougier system.

A 360-FOOT ROLLING BRIDGE.

WERE the exact figure of the effective span of the rolling bridge illustrated herewith required, we should say that it was 359.8 feet, but we have taken the liberty of making it an even 360 feet in the title, so as to avoid confusion. By actual measurement, however, the span exceeds that of any bridge hitherto built with the same kind of construction.

This gigantic bridge is to be seen at the great establishment owned by Messrs. Vickers, Sons & Maxim, the famous gun manufacturers, and situated upon the river Don at Sheffield. In these works, as well as in the other establishments of the same firm, all the machinery has for some time been actuated by electricity, and by this power, too, is operated the carrier of the bridge under construction, which is designed to put the main works in easy communication with an annex across the river where are stored at least 10,000 tons of iron and steel for the daily needs of the establishment. It should be stated that the water course at this point is at least 120 feet in width, and it became necessary to have a ready means of transporting across the river the heavy loads of metal to be treated in the works. With this object in view, a true cantilever bridge was built, and this supports, and, indeed, we might say constitutes, the track of a rolling platform. The structure has no stationary piers, but is supported by metal pillars mounted upon wheels, which roll upon a track laid upon each side of the river Don. The tracks are 196 feet apart; but on the side upon which the main tracks are situated the bridge is completed by a 45-foot cantilever, in order that the carrier or rolling platform may empty its load into cars running upon the numerous tracks in the yard. On the other side of the stream there is a 128-foot cantilever to allow the platform to reach the different piles of metal and be loaded directly from them. The bridge can be moved in a direction at right angles to its axis, at the same time that the platform is raised or lowered or is running upon the upper track. These three motions are controlled by a single operator, who stands in a special cab built upon one of the pillars of the bridge. All the motions are given by a single electric motor of 85 horse power. The power is transmitted to the wheels that support the pillars by suitable shafts and bevel gears. The movement of the trolley of the platform is obtained by means of two cables that wind in opposite directions around two drums mounted upon the platform, one of which winds up while the other is unwinding. The raising of the load is done by another drum. When the load is descending this latter is allowed to unwind, being regulated by a brake. The load is 5 tons at a maximum, and is raised at the rate of 250 feet per minute. The platform rolls over the bridge at a speed of 698 feet a minute, and the entire structure can be displaced in a direction parallel with the river at a speed of 98 feet a minute.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.



A 360-FOOT ROLLING BRIDGE.

HAMMERS—HOW THEY ARE MADE.

THE mechanic's hammer of to-day is essentially an American product. This is the age of hammers, in view of the fact that this age sees the hammer in its greatest state of efficiency, says The American Exporter. Exactly when the hammer came into use is not told in history, but it is certain that some rude form of the instrument must have been used in the earliest days of handicraft. Of the hammers made in America to-day there is no end. There is the tiny little tack hammer which weighs only a few ounces, and is indispensable in house, store or factory. Then there is the twenty and thirty ton hammer driven by steam and used for making immense forgings. The numberless effects which are due to its remarkable force of impact have made the hammer a necessity in all trades. Immense manufactories, employing thousands of men, are grinding year in and year out making hammers, while ten times as many wholesale houses are busy putting the product on the market. The industry has advanced to such a stage that many general hardware firms in the United States have thrown out the hammer, leaving it to the houses that deal in tools exclusively.

Hammers are made in a variety of shapes, the most in demand being the claw hammer. This and the shoemaker's hammer have retained their shapes for hundreds of years. One gold beating firm relies on them entirely. The sheets or leaves of gold are hammered to such exceeding thinness that two hundred and fifty thousand are required to make up the thickness of an inch. Another odd product of the hammer factory is the butcher's hammer, used for killing cattle. It is capable when properly wielded of carrying a very heavy blow. Then there are the stonecutter's hammer, the carpet layer's hammer, the wood carver's mallet and the plumber's odd implement. All of these have a good sale in the markets of the world, because they possess a "something" which users cannot find duplicated in the output of other countries.

In the South Sea Islands tree-felling contests are of such importance that specially made axes are imported for the work from America. It is reported by way of illustration that a difference of half an ounce in the "heft" of an ax lost the championship to one skilled chopper who had retained it for a quarter of a century. He was compelled to accept an ax of European make, and although it was to the eye of the layman equal in every way to the Yankee product, something was missing, and all sorts of tests were made to discover what it was. The heartbroken ex-champion finally agreed that the difference lay in a slight curve of the handle and an excess weight of half an ounce in the head. So skilled are these woodmen of the South Seas in felling timber that a dozen blows on the trunk of a tree will show but the one gash, as though done by a single blow of mighty power.

In the manufacture of claw hammers the American foundryman sees to it that the instrument balances perfectly before it is passed as being O. K. By balancing is meant that the center of gravity, when the hammer is standing on its head, runs from the apex of the claw diagonally through the handle, just touching the very edge of the end surface. If the instrument fails to pass this test it is rejected and either sold for a low price, without a name, or consigned to a scrap pile. Small as such a defect might seem in itself, the amount of excess energy required to wield the implement would run up into several horse power in the course of the life of one hammer alone. A mechanic of to-day is a man of brains as well as muscle, and the same tension or "edge," requisite in artistic piano playing, oil painting, and billiard playing is necessary in the crafts, although naturally in a lesser degree.

The manufacture of tools for the various divisions of labor has, therefore, become in this country something more than an output of units in enormous quantities. There must be a spirit of harmony between maker and user, and the needs of the latter taken seriously into consideration. An illustration of this was shown in England recently where American bricklayers amazed the native worker by laying fully 60 per cent more bricks in one day than the best British record. Investigation disclosed the fact that the bricks were made on the American plan, somewhat smaller in every way than those in general use in England. The cry went up that no comparison was possible, in view of this glaring discrepancy, and the trade press was occupied with the controversy for many days.

Our English cousin failed to take into consideration the fact that the extra energy required to handle a brick, somewhat unwieldy and overweighted from the American standpoint, would reduce the earning power of the individual and the corresponding percentage of profit of his employer. The wonderful display of rapidity and mechanical skill of the American artisans has led to a more or less acceptance of the American model of brick in factory construction in England. The same conditions exist in the realm of tool manufacture. It is true that finer grades of instruments, those for the engineering and kindred professions, are generally imported from Germany, but even these are having a difficult time of it in holding the premiership against instruments of American make.

In the hammer industry, on the other hand, the American product is par excellence. It is made to fit every requirement of a driving tool. One individual of the family, the magnet hammer, has a loadstone in its head, and every little tack jumps at it. The magnet hammer is very useful where canvas is being tacked on the walls. It saves the user the trouble of holding the tack and taking chances at smashing his fingers. The magnet hammer is much in use in tacking tin signs on trees. It is necessary to secure the advertisement at a height beyond the reach of the small boy, and the magnet hammer answers the requirement. A clip on the side holds the card or sheet of tin while a tack is retained in position by the magnetized head. One firm blow drives the tack through the tin into the fence or tree trunk and secures the sign sufficiently to enable the workman to

withdraw the hammer, clip and all, and permit him to drive a second tack. The handle is made on the extension plan, similar to a fishing rod, and when not in use can be carried in a very compact space.

After the hammer that is driven by hand comes the steam hammer. But before the steam device was known there was a hammer called the Hercules, which was a ponderous mass of iron attached to a vertical guide rod, which was lifted originally by a gang of men with ropes, and allowed to fall of its own weight. This was an efficient tool for forging large anchors and for similar purposes, but the necessity for a more rapid motion was soon felt. The lift or helve and the tilt hammer then came into use. These were lifted and dropped at regular intervals by steam power. The first really remarkable invention in the way of a hammer was patented in 1842. The virtue of this hammer was that it was able to deliver blows the force of which could be estimated, at the same time being under such perfect control that a hickory nut could be cracked without injury to the kernel. The largest in existence are the duplex hammers which weigh as much as twenty or thirty tons. They possess two hammer heads of equal weight, made to deliver horizontal blows of equal force simultaneously on each side of the forging. These are only used for very heavy work.

REGENERATION OF THE WASTE OR RESIDUE OF SULPHURIC ACID PROCEEDING FROM THE TREATMENT OF MINERAL OILS.

The waste or residue of sulphuric acid proceeding from the industries of paraffine, mineral oils and petroleum is an almost valueless product, on account of the organic substances contained in it, and very difficult of removal. The following process allows of the regeneration of this waste in such a way as to be utilized chemically.

The waste pulverized by watering or by jets of air, in the form of thin jets or drops, is introduced in presence of air into an iron retort heated to the red, or some other receiver. On contact with the incandescent iron wall, the organic substances are burned, yielding carbonic acid and water.

The gases, thus disengaged, are directed by the aid of a chimney or an aspirating ventilator into a Glover condenser, in which sulphuric acid is streaming. The latter acid draws from the mixture the sulphuric acid contained in it, while the carbonic acid continues on its way without being dissolved. The sulphuric acid, thus regenerated, is forced in part into the Glover condenser, in order to absorb new quantities of gas. This regenerated acid is pure, allowing of further concentration without formation of froth. When the residue thus evaporated, contains more than 50 per cent of anhydrous sulphuric acid, the regenerated acid may be utilized directly for the manufacture of superphosphates and for a large number of other uses.—La Revue des Produits Chimiques.

WATER TUBE BOILERS.—III.

By the English Correspondent of the Scientific American.

THE BRITISH STIRLING WATER TUBE BOILER.

The several trials carried out by the British Admiralty Boiler Committee brought to light a comparatively new type of water tube boiler—the British Stirling.

This boiler distinctly differs from all other water tube boilers, as will be seen from our illustration; and though from a cursory observation it may appear intricate—the most adverse feature of a water tube boiler—in reality it is exceedingly simple, both in design and action. At the top of the boiler three horizontal water drums are placed, supported by strong steel framing. The tubes extend downward from these three drums at a slight angle from the vertical, to one, or two, drums at the lower end. At the points where the tubes enter the drums they are slightly curved, but the bend is quite an easy one. Now, the peculiar feature about the general design of this boiler is, that although the top horizontal drums are fixed and well provided against rolling at sea, and to all intents and purposes perfectly rigid, the lower drum or drums are not, but are suspended from the tubes. By this arrangement any expansion or contraction of the tube that may be set up by the fluctuating temperature of the gases, does not throw any strains upon the fixed portions of the boiler. For instance, if the lower drums were fixed and rigid, great racking strains on the tubes would be set up, with the result that weaknesses would develop; but as the lower drums are not fixed, the whole of the structure coming into contact with the gases of the furnace has free play. At first sight, it may be considered that the heavy weight of the lower drum, or drums, when full of water would in itself throw a stress upon the tubes, and thus militate against the boiler being absolutely safe in its working, but experiments have proved that the force required to draw one tube from the plate is about twenty-five times in excess of the unbalanced internal pressure. Under these circumstances, therefore, the element of safety is highly assured.

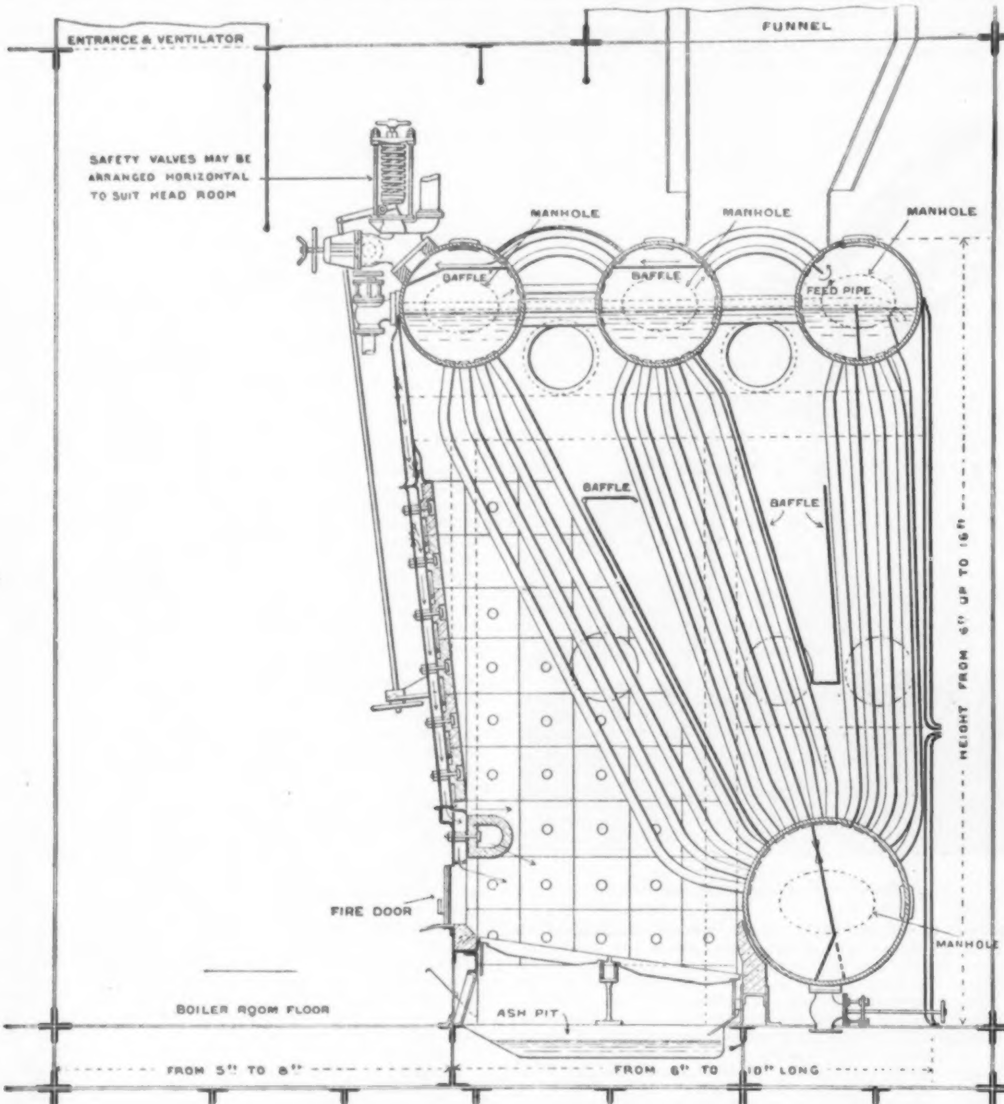


Fig. 1.—STIRLING BOILER FOUR-DRUM TYPE.

It will be also observed by reference to the accompanying illustration that the arrangement of the furnace is entirely different from that generally in vogue with water tube boilers, being placed at the right-hand bottom corner of the boiler. This is a very convenient design, as the grate area can easily be accommodated to the space available for the installation of the boiler. It also permits of a wide and short grate, thus enabling the firemen to work the furnace properly, and not necessitating such skillful and careful stoking as is required where a long narrow firebox is obtained.

The path the gases follow from the fire to the chimney is clearly demonstrated in Fig. 1. The combustion chamber is very large, and as the gases rise from the furnace they play upon the front of the first nest of tubes until they reach the top asbestos lining of the boiler, when they are deflected, and follow a downward course over the second series of tubes to the bottom of the boiler, then rise once more over the third element of tubes to the top, after which they rise through the uptake and escape to the chimney. The gases cannot return to the fire, or remain stagnant around any particular nest of tubes, since between each series an asbestos baffle plate is placed, and therefore they have to travel along this zigzag course around the tubes. The gases have to follow a long passage, so that by the time they escape through the chimney, nearly all the heat is absorbed, and thus only the minimum of heat is wasted, and the funnel never becomes hot, even when the boiler is forced to its maximum. To insure the utilization of the heat to the utmost degree, the tubes in each bank are staggered, thus breaking up the gases into small sections, so that they can become intimately commingled. By this ingenious arrangement, another very important point is achieved. The resistance to the gases is so very trivial that it is possible to burn a heavy fire in the furnace with a very moderate draught in the flues. Also, no heat is wasted upon the casing of the boiler, owing to its being lined throughout with fire-resisting material. Furthermore, owing to the special design of the combustion chamber, inferior fuel and refuse can be consumed with highly satisfactory results. Several of the land-type British Stirling boilers, which closely resemble the marine design, and many of which are in use in Great Britain, are being fired with slack dross, grum, smudge, culm, and coke breeze, and other equally inferior fuels, and are giving the greatest satisfaction, a consideration of vital importance in places where it is necessary to run the boiler as cheaply as possible, and where it is desired to burn refuse with a profit.

An instance of the efficiency of this type of boiler in this direction was demonstrated at an iron-smelting firm in Sheffield, where a British Stirling boiler with 3,610 square feet heating surface, hand fired, evaporated 14,000 pounds of water when fired with thin Yorkshire slack. Experiments are to be carried out by the manufacturers of the boiler at their Glasgow works for the purpose of utilizing liquid fuel, which promises to displace all other types of fuel in the near future.

The tubes are of the large type, being as a rule 3¼-inch external diameter. In the case of a boiler of 5 drums—three top steam and two lower water feed—where the tubes at the back end stand practically vertical, while at the front end over the furnace they are inclined at about two (vertical) to one (horizontal), an ingenious system of interconnection is adopted. The nest of tubes immediately over the furnace is connected with the front top steam drum and the front lower water drum; the second bank of tubes connects with the middle steam drum and the front lower water drum; the third bank with the middle steam drum and the rear water drum; and the fourth bank with the rear steam drum and the rear water drum. The tubes are straight throughout the greater part of their length, and are only easily curved at each end to enable them to enter the drums as perpendicularly as possible. They are bell-mouthed and of weldless steel, and are expanded into the drums. By this arrangement each tube becomes a stay tube, and perfect tightness is insured at the joints, so that there cannot possibly be any leakage. Although the tubes are slightly curved, this does not entail the stocking of a variety of bent tubes to replace any that might give out, but the tubes are supplied straight, and can be bent to the requisite curve over a bend block which is provided. This simple process renders the Stirling boiler an easy one to repair, since in the event of a tube proving defective, a workman can enter the boiler and get between each bank of tubes, for which purpose ample room is provided, and replace the damaged tube without injuring the others; or if it is impossible to stop the boiler long enough to remove the damaged tube there and then, it can be plugged in a few minutes, and repaired when opportunity offers. The tubes are easily accessible through doors in the casing plates of the boiler.

The drums can also be quickly and easily inspected and cleaned by means of a manhole at one end. The drum ends are dished without stays, and the manhole door is of the stamped steel type with internal pressure, so that even should the dogbolts which secure it give out, when tightening up under steam pressure, no apprehension need be entertained as to their safety.

The two water drums are connected by means of a short curved cross pipe, and always maintain an adequate supply of water at the bottom of each tube, to supplant the steam. It is therefore impossible for the tubes at any time to be charged with steam only, no matter to what extent the firing may be forced. The top drums are also half filled with water, so that the boiler belongs to the "drowned" class, i. e., the steam is delivered below the water level. The upper part of the front and middle steam drums are baffled, and reference to Fig. 2 will lucidly demonstrate the principle of circulation. As with the water drums, the steam drums are connected by cross pipes, and the steam outlet is of a peculiar design. The feed water flows through the feed valve and is delivered into the rear drum, and a pipe just above the interior asbestos lining of the boiler connects each drum, so that an equal level of water is maintained in each. Above the water level two pipes, one curved and the other straight, connect the front with the middle, and a curved cross pipe connects the middle with the back steam drums. These outlets are placed below the division plate in each drum. It will be noticed by referring to the diagram that the feed water is delivered into the rear drum in such a way that it does not interfere, or mix, with the main circulation. The water flows through the last bank of tubes from the rear steam drum, and the third bank of tubes from the mid steam drum into the rear water drum. That is to say, the third and fourth nests of tubes are downcomers, and the first and second banks upcomers. The steam, upon its delivery into the steam space into the front drum, passes through the cross steam tubes in the steam space in the mid-drum, where it mingles with the steam delivered into that drum and passes again through the cross steam tubes into the rear drum. The rear drum has no division plate, and the steam now re-

turns through a cross curved steam tube placed above the former, to the mid-drum, where it is delivered into the steam space above the division plate. It continues its journey from the mid-drum through a similar cross steam tube into the front drum, and then passes through the steam valve to the engine.

It may be remarked that this is a very elaborate process of circulation, but it is nevertheless ingenious, for it insures the steam being very dry by the time it reaches the main steam pipe to the engine. Then, again, priming cannot possibly occur, since when the steam reaches the rear drum, it is practically quiescent, while the water is flowing downward and in an opposite direction, so that it cannot possibly mix with the steam. Besides this, since the gases from the furnaces, after they have left the combustion chamber, pass over the top of the boiler to the chimney, any further heat they may contain is partially absorbed, thus assisting in the drying of the steam. It will thus be seen that circulation is both rapid and efficient. Every tube has a free outlet to the drums at each end, and there are no rivets or other obstacles of any description to impede the free passage of the steam. The latter is also generated in the two front banks of tubes, and these being inclined at an angle enable the steam to pass upward freely. This rapid system of circulation, combined with the thin envelope of metal to the tubes, renders the Stirling boiler economical and efficient in a vessel for all speeds. These characteristics render it highly suitable for warships, where the demand upon the steam supply is varied and intermittent—at one time low pressure, and at another high pressure. It can be forced to any extent, without any deterioration in the quality of the steam, without any injury to the boiler, and steam can be raised from the minimum to the maximum pressure at very short notice.

Another significant feature of this boiler is that it can be easily adapted to limited floor space without interfering with its efficiency or diverging from its general characteristics. In such cases, one large water drum is suspended from the tubes instead of two, and the tubes are compressed into three banks instead of four. Of course, in these instances the boilers are somewhat cramped, and the tubes approach more the vertical in position—the last nest of tubes is almost perfectly perpendicular. By this arrangement, however, the combustion chamber is not reduced in size. There are the same large steam and water spaces, and the large disengaging area for liberating the steam and avoiding priming.

There is one point, however, about the four-drum type of boiler which might call for derogatory criticism. As so many tubes enter the water boiler, it may be averred that such a free perforation of the tube plate causes a decided weakness. This is not so, ample plate thickness equal to a factor of safety of 6 being always provided.

Salt water can be used for these boilers without exercising any ill effects either from corrosion or scale, since it is the nest of tubes farthest removed from the fire wherein any such deposit is made, and the general working of the boiler is not affected thereby. Again, the vertical arrangement of the tubes insures the tubes being practically free from deposits of soot, since the latter is precipitated to the bottom of the boiler by gravitation and can be removed. Even the interior of the tubes can be easily scraped and cleaned, as the easy bend imparted to them does not interfere with the insertion of brushes and scrapers.

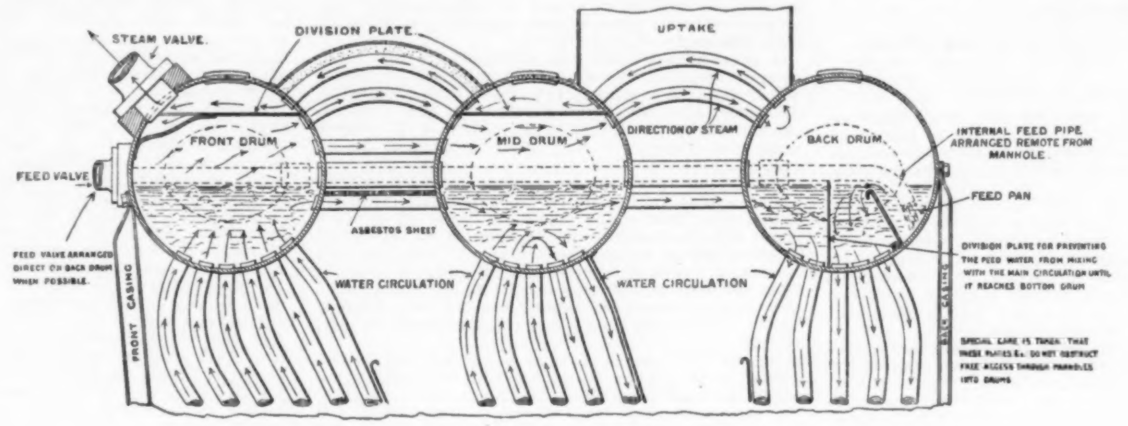


FIG. 2.—CIRCULATION DIAGRAMS OF THE STIRLING BOILER

DA VINCI'S MANUSCRIPTS.

THE history of the dispersion of the drawings and manuscripts of Leonardo da Vinci has been narrated by Mazenta. Leonardo, dying at the château of St. Cloux, at Amboise, bequeathed them to his favorite pupil, Francesco Melzo, evidently with the desire that his writings should be edited and published. Melzo seems to have commenced the task by the compilation from the various books of the "Trattato della Pittura," but he did not publish it. Indeed, it remained in manuscript till Poussin, seeing its value, designed illustrations for it, and persuaded Raphael Trich[illegible] to give it to the world, which was done in 1651. Needless to say, there have been many editions in various languages since that time. The most valuable has hitherto been an edition printed at Rome, from a manuscript in the library of the Vatican, in the year 1817, and edited by the Abbate Manzi. Several years ago there was published a fresh edition of the Vatican codex, edited by Herr Ludwig. It forms the last three volumes of Prof. Von Edelberg's "Quellenschriften für Kunstgeschichte." A valuable contribution to the literature of the subject is "Das Malerbuch des Leonardo da Vinci," by Dr. Max Jordan, director of the Berlin National Gallery. To return to Melzo, whom Vasari styles a handsome and amiable old man. He outlived his master probably half a century, but seems to have been sadly remiss in fulfilling his duties as literary executor; neither did he take proper steps to maintain intact his precious legacy after his own decease. The manuscripts and drawings were then held to be of extraordinary value; the cupidity of collectors was excited, and very shortly their dispersion commenced. Then for more than two centuries they were regarded as objects of rarity, and eagerly sought after by *virtuosi;* Arconati was offered more than 2,000*l.* by Charles I. for some volumes in his possession. To master their contents, however, was the last thing thought of, precisely as many a modern bibliophile never reads a page of his *incunabula.* The painter Louis Antoine David was the first person who seems to have seriously set about the study of Leonardo's writings. He relates how he esteemed himself fortunate if, after four hours' study, he was able to decipher a page of the manuscript. His labors, however, did not result in publication, and it was not till 1797 that any really valuable account of Leonardo's scientific studies appeared in print. It is to J. B. Venturi, an Italian professor, settled at Paris, we are indebted for the first insight into these hitherto unexplored documents. The title of Venturi's work is "Essai sur les ouvrages physico-mathématiques de Léonard de Vinci, avec des fragmens tirés de ses manuscrits apportés de [illegible] c. Paris, 1797." It still remains one of the

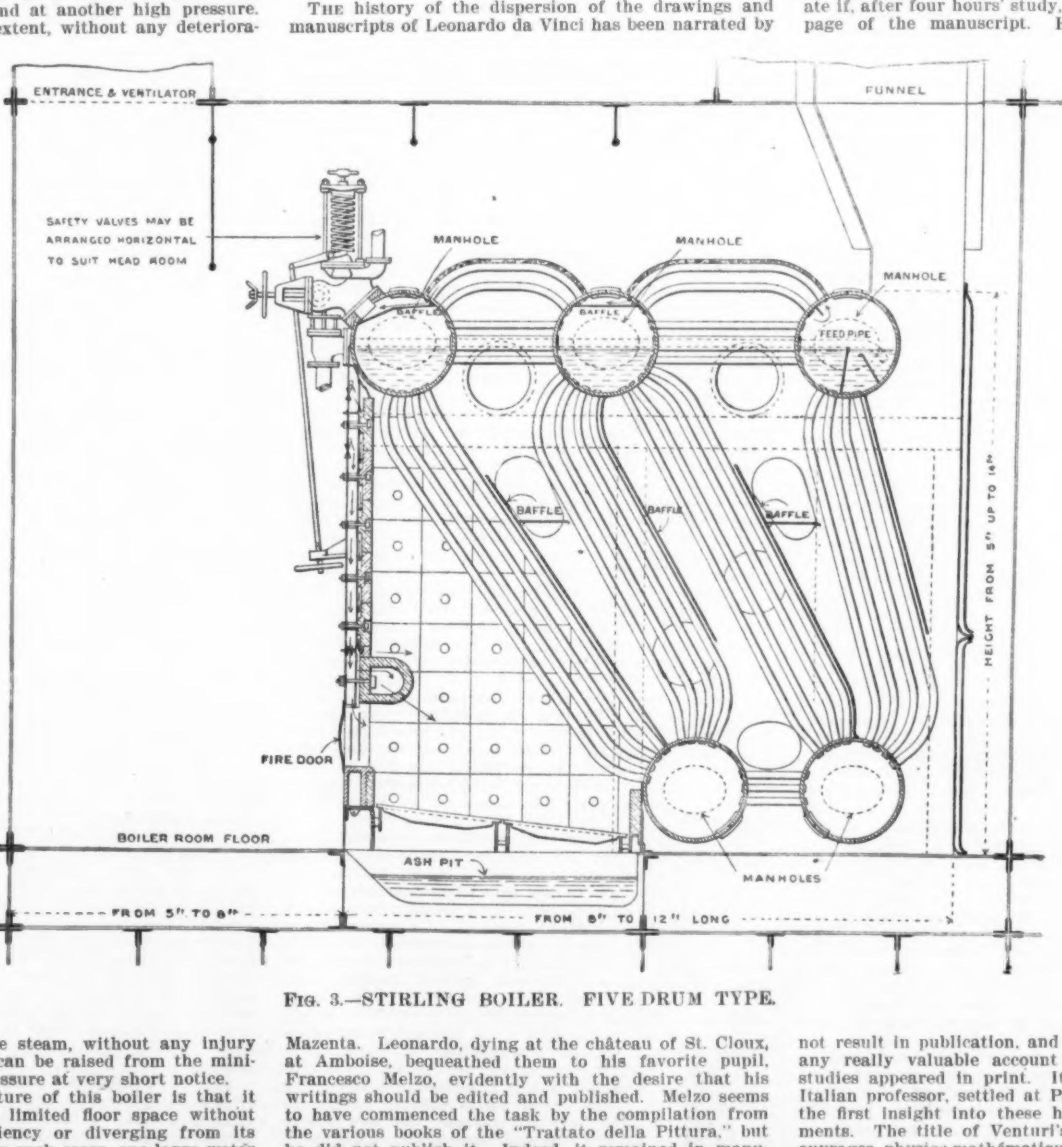


FIG. 3.—STIRLING BOILER. FIVE DRUM TYPE.

most useful aids to the study of Leonardo. Being now very scarce, a reprint would be a boon for which students would be grateful. Since Venturi's essay there has been a continuous series of works illustrating various phases of Leonardo's activity, of which Amoretti's "Memorie Storiche" and Bossi's "Cenacolo" may be cited with approval. To enumerate the various lives, monographs and treatises would take up considerable space, for the literature of Leonardo fills a goodly library shelf.—Architect and Contract Reporter.

THE MECHANICAL INVENTORS OF LANCASHIRE, ENGLAND.

THEIR INFLUENCE ON SOME BRITISH AND FOREIGN INDUSTRIES.

By SIR W. H. BAILEY.

IT is profitable for commercial men at all times to study industrial history, the fluctuations of industrial geography, and the causes that have led to the foundation of the great industries of manufacturing districts.

With this thought in mind, the writer undertook, a short time ago, to collect and present in an address before the Manchester Literary and Philosophical Society, the names of men of mechanical genius of the great British industrial community of Lancashire—men who have assisted in notable degree in founding British industry; and the outcome was substantially what is given in the following pages.

Industrial history enables us to measure and assess our position in relation to that of our competitors abroad. The causes that have given us command of markets may operate against us if we ignore the obvious. Commercial centers have from time to time moved from one district to another, and from one country to another. The causes of these movements are often apparent. The discovery of doubling the Cape by Vasco da Gama in the year 1497 was a great blow to the ancient commerce of Venice, and generally to the industries of Mediterranean cities. This new way by water to the Indies increased the prosperity of Spain and Portugal for a time; but Antwerp, Amsterdam, and the Low Countries were much more benefited. The superior methods of distributing goods by the sea-going Dutch ships and their mechanical inventions all were contributory factors to their success.

In the seventeenth century science began to influence industry, and in this new departure Florence was conspicuous. Florence was then the very brain of civilization, for the physical investigators of this illustrious seat of learning in the first half of the century—Galileo and Torricelli and others—had an immediate influence on the early steam engine, the sextant, the chronometer, and other inventions of Great Britain. Torricelli invented the barometer for indicating the pressure of the atmosphere; we had the thermometer and the pendulum and the telescope and microscope from Galileo; and, only a few years afterward, in Great Britain, after being thus taught to see and weigh and measure heat and cold, to examine the mysterious causes of vacuum, and to value the pressure of the atmosphere, we received the experimental engines from the Marquis of Worcester in 1663, and Savery's engine in 1698, while Newcomen invented his simple vacuum or atmospheric engine in 1712, which, we must not forget, did useful work in England for a hundred years before James Watt's double-acting engine with the conical pendulum or governor balls for controlling it became recognized and popular.

It was at Florence that the first scientific academy in Europe was founded by Prince Leopold of Tuscany, in the year 1657, and the second scientific society was the Royal Society, in London, whose charter was granted in the year 1662.

If we picture the industrial map of Europe in our imagination as it was in 1700, we find that in Great Britain, with the exception of one or two early inventions of steam engines and some improvements in watches and clocks, we were not superior, nor even equal, to the manufacturers on the Continent.

We had a small trade in London, Bristol, Sheffield, Birmingham, and Manchester; but we bought all our bar iron from the Continent, for in 1676 Andrew Yarranton, who wrote on the improvement of England, said that we had no rolling mills in this country at that period, nor for many years after. We imported all our hollow-ware of cast iron; all cooking pots came from Holland. We made a few anchors ourselves, and we had a small trade in wrought-iron pans and shovels in Wigan and in the black country, and our chain smiths were very ingenious; but the iron bars came from abroad. Round and square iron was hammered to shape laboriously on the anvil, or by swages and tilt hammers, but it was poor in quality; the use of charcoal had been prohibited, and coke had not been perfected. Better methods of dyeing and bleaching were being introduced by refugees into Lancashire, as silk manufacture had been introduced in the south of England by the Huguenots some years before this. In spinning and weaving, bleaching and dyeing we were inferior to the people of the Low Countries, and about this period the Dutch loom, which was much better than ours, was introduced into Lancashire.

Paper making had been introduced by foreigners as early as the time of Henry VIII., and a few mills existed in the time of Elizabeth; but the best paper for printing books came from the Continent. Oliver Cromwell remitted the duty on the paper for printing the "Polyglot Bible," which came from Holland. Goldsmiths of Bristol and York and London were very ingenious and did some good work; but in metal and in textile fabrics, both in design and manufacture, we were very much inferior to foreign countries.

Dutchmen were engaged in the erection of water supplies and pumps, and the Norfolk Broads and the Bedford Level were finished under Dutch management, in the time of Charles the Second. Improved windmills were introduced from Holland, and the waterwheel was being brought over; indeed, the manufacturers of the Low Countries, of Haarlem, Bruges, Antwerp, and let us not forget Barcelona in cotton goods, were supreme in the commerce of Europe, especially in export trade at this particular period; Barcelona was the Cottonopolis of Europe for one thousand years before the mechanical inventions placed Manchester in that position. Barcelona was the market for raw cotton up to the year 1790, after which Liverpool gradually took this position.

Soon after the commencement of the eighteenth century Manchester and Liverpool were becoming more important, and the growing industries of South Lancashire caused some of the most prominent and active men of Manchester to obtain a bill for making the River Irwell navigable to the Mersey and to the sea. This scheme was sanctioned by Parliament in the year 1720. This increased facility for exporting manufactured goods and for obtaining the raw material from foreign countries gave a great impetus to the industrial prosperity of Lancashire.

A great export trade was springing up, and there was an increasing demand for textile manufactures, which appeared to sharpen the wits of those engaged in the trade, and the very first invention that doubled, and in some cases trebled, the production of the weaver came from a native of Bury—the invention of the fly shuttle in the year 1733.

Before this invention for weaving we were not superior to any in the world. The mummy cloths of Egypt, the robes of the Queen of Sheba or of Cleopatra, and the tapestries of Babylon, or the vestments of the cavaliers, the garments of Queen Anne, were all spun and woven by simple tools differing very little from one another. The distaff and the spinster's wheel and rude frames called looms were the only methods known to mankind before this great invention of Kay, of Bury.

Wonderfully simple it was, a carriage on rollers propelled by a piece of string, and two pickers enabled one man to do the work of three or even four, for before this, for broad pieces, two men were employed to throw the shuttle to each other and one man to push up the beam, as described by Dyer, the poet:

"Or if the broader mantle to the task,
He chooses some companion to his toil;
From side to side with amicable aim,
Each to the other darts the nimble bolt;
While friendly converse, prompted by the work,
Kindles improvement in the opening mind."

This new system of weaving quickly exhausted all the productions of the spinsters, and their work went up to a premium, for the new looms could use more weft and warp in a day than the spinsters produced in a week. The speed of the shuttle gave it the name of the "fly shuttle." Inventors next began to consider how to increase the production of the spinning wheel. Before I allude to this let me say that Kay invented many other machines for carding or combing cotton and others, which may be seen in the Patent Museum in South Kensington. He was beset and picketed and much ill-used by those whom he benefited. He had to leave Bury to save his life, and died in poverty and obscurity in France, and it is not known where he is buried.

Kay invented a power loom, which he was unable to introduce. His brother, Robert Kay, invented the drop box for different colors to be used in weaving.

James Hargreaves, of Blackburn, and Thomas Hayes, of Leigh, both endeavored to supply the great demand for yarns produced by Kay's new loom. I have devoted considerable time to investigate the claims of both, and am inclined to believe that independently of each other they simultaneously invented the spinning jenny. Between 1766 and 1769 Hayes produced one with six spindles, and about the same time Hargreaves produced one with twelve spindles.

The spinning jenny was very much enlarged until the introduction of spinning by rollers. These rollers, going at different speeds, elongated the fiber preparatory to its being spun. Hayes invented this in 1767, although he had been anticipated by Lewis Paul, of Birmingham, whose crude claims deserve some consideration, and in 1770 Hargreaves exhibited a double jenny with twelve spindles on the Manchester Exchange, and became a man of repute among the men of Manchester who presented him with a testimonial and 200 guineas.

The next important invention was that of Samuel Crompton, of Bolton, for, with all the new inventions for spinning, it was still found impossible to fill the mouth of the new loom. Quite a famine was created, and in the year 1775 Crompton, of Bolton, invented the spinning mule. He mounted a great number of spindles on a movable carriage, with which by being pushed backward and forward one man could do an enormous amount of work. In 1811 the government made him a grant of £5,000.

The reports of the exports and imports of fine yarn about this period, up to about 1805, show that we had imported most of our fine yarns from India. Crompton's mule stopped this importation, and we began to send fine yarns back to that country. The production of Crompton's mule enabled men to earn more than ten times the wages of the poor Indian handicraftsman, and to send fine yarn at a cheaper rate than it could be produced in the home of the cotton plant. Crompton, as usual, was in great fear at one time because of the enmity of workmen. He died in 1827, and in the year 1862 Bolton erected a fine bronze monument to commemorate his name as a public benefactor.

Another new era soon commenced—the power of these ingenious machines for spinning and weaving was about to be further increased. James Watt's new double-acting steam engine was being introduced into the manufacturing districts, and many men applied themselves to drive Kay's loom and Crompton's mule by steam power, and a Kentish clergyman, Dr. Cartwright, took out a patent for a steam loom; but the practical invention of the new weaving machines was the work of Radcliffe and Horrocks, two Stockport manufacturers and inventors, in the year 1805. Stockport is just on the border-line of Lancashire and Cheshire; but it is so near (indeed, part of Stockport is in Lancashire) that for practical purposes we will give that enterprising and much esteemed old town the benefit of the doubt. Here again another famine in yarn was created, for the moment the new steam looms began to work at enormous speed, all Crompton's mules, which were producing good work all over the county, could not supply the demand for warp and weft, and for a long period this demand for steam spinning did not produce the man.

The steam spinning machine, the self-acting mule, is probably one of the most ingenious of the many remarkable and clever appliances used in cotton manufacture. It was not until the year 1834 that Richard Roberts produced his first self-acting mule. We cannot call him a Lancashire man; but his mother was born in Liverpool, and his father was a poor Welsh shoemaker. Roberts was born at Lanymynech, near Welshpool.

Roberts, if not the greatest mechanical inventor of the nineteenth century, was the last of the great inventors of those original departures—parent inventions for textile manufacturers. The self-acting mule is so well known that I will not go into any description. It is used extensively all over the world, and has been one of the greatest inventions that has placed Lancashire manufacturers in the front rank.

Everything that Roberts touched seemed to become alive; he had the wand and power of Prospero. Richard Roberts made dry bones live. The only difference in poets and inventors and sculptors in their art of expression is in the materials of construction used to build what is in their imagination; one builds of marble and another of solid bronze. The poet sings his melody, and in words which

"Like the bow that spans the sky,
Brings colors from heaven that never die."

The sculptor sees the angel or the god in the rough marble block and chisels away the covering that hides it from the gaze of man. The inventor's imagination sees the perfect machine working before he places it in black or white on paper, and the expression of his genius is in the complete invention.

Roberts has not given us poems of lyric beauty, but his art and execution had all the quality of our great poets; his fingers were the obedient servants of his opulent imagination, for his exquisite drawings were perfect; his taste was equal to his skill, for his mind and his fingers were in true partnership. He never went to school, and yet he was an accomplished mathematician, and employed the highest skill in his drawing office. He had a staff of educated men, and was very exact; he would not permit experimental work to proceed until high-class detailed drawings were all made. I knew him as a boy, and it was my good fortune often to see him. He always said that a piece of black lead pencil and paper were far cheaper materials for experiments than making rough models without any proper scheme in black and white on the drawing board.

Roberts invented the slide lathe, and the first one is working at the works of Messrs. Beyer, Peacock & Co., at Gorton. The carriage of the lathe is on the front of the bed and not on the top, and this idea is coming again to the front in some American and German lathes I have seen recently.

He also invented the planing machine for planing metals. I remember seeing some of the early ones driven by hand with a barrel and an endless rope; a man turned round when he got to the end of the stroke and with a windlass wheel pulled the carriage back again. Afterward more complete machines were made, chiefly driven by chains. These, again, were much improved by William Muir and Sir Joseph Whitworth. I know about the same time Fox, of Derby, is said to have invented the planing machine; but I think Roberts was a little earlier in the field. Maudslay had invented the slide rest in London, and Roberts had been working there as a young man, and having seen the slide rest, when a long job had to be turned, it was almost natural for an ingenious man like him to invent the slide lathe.

Roberts invented an automatic emery wheel with a slide arrangement for grinding and polishing—very accurate and beautiful in its action—similar to those that have been invented of late in America and sold in England as novelties. I worked one when I was an apprentice. He brought out some of the early slotting machines, and a pentagraph automatic drilling machine for drilling holes without the use of a center punch. A dummy or model was placed in position; the drilling machine then imitated it on a piece of metal, and drilled as many holes as the model had. He took out many patents for weaving carpets. He invented a reed-making machine. He designed twin-screw propellers—one called the "Flora," as a blockade runner in 1862, which could turn in its own length, and was the forerunner of that type of steamboat. He designed the first locomotive made in Manchester—practically the modern locomotive. His Jacquard punching machine for punching the plates of the Britannia Tubular Bridge—mezzo-tinted in metal, if I may coin a word—does what the Jacquard loom does for silk. By placing a card in the punching machine he would punch holes to any pattern, even a portrait.

This punching machine was used for the Menai, the Conway, the St. Lawrence, the Victor Emanuel, and many other tubular bridges. His firm, Sharp & Roberts, made them for Messrs. Peto, Brassey & Co. His improvements in electro-magnets, timepieces, and watches, in weaving, in automatic valves and water meters, ventilators for boats, the modern swivel anchors now in use, engraving machines, and a host of other appliances would take a long time to describe; but his self-acting mule was his greatest achievement, which he designed and made in thirteen weeks.

He died poor, although the men of Manchester agreed to allow him £1,000 a year if he would come to live in Manchester, for he had gone to reside in London, and lies buried in Kensal Green Cemetery. I hope some day we may have a monument in Manchester to commemorate the great benefactions of this greatest English inventor. When a boy I was permitted to go about in the works of his last firm, Roberts, Fothergill & Dobinson. The works had an armory in Falkner Street in 1857, and loopholes were over the gates to enable the place to be defended from attack.

John Wilkinson, the inventor of the first iron boat, which was placed on the water in 1786, was born in Cartmeal. The influence of this invention on our mercantile marine has been enormous, self-evident, and apparent; but the invention was for a long time waiting for the tools to be invented before it could be

manufactured on a large scale, and then it became a formidable competitor with the wooden boats of the United States and other countries.

Even so recently as 1850 the United States had the fastest and largest ships in the world. Many of us will remember that the clipper sailing ships brought the first cargo of tea from China round the Cape, and brought the cotton supply from the Southern States to Liverpool, and Canadian timber and other wood in abundance, and at that period our total tonnage of mercantile ships was about equal to that possessed by the United States. Since that time our fleet of sailing vessels and steamships, chiefly steel, had become greater than the combined fleets of the nations of the world. Cheapness in production must be the cause of this.

Wilkinson and his father took out a patent for box irons for laundries. They were too poor to have a foundry of their own, and therefore bought the molten metal from a little foundry opposite their workshop. Wilkinson hawked their productions, and in course of time became prosperous. He is a somewhat isolated instance of a wealthy inventor; he died worth probably about one million sterling. He invented the hot blast for iron melting and the steam blower, and made the first boring machine for engine cylinders, for he had been making cannon and had invented boring appliances, and, coming in contact with James Watt, they became great friends.

Some of the early engine cylinders before Watt's time were not bored at all. The Newcomen engines were made in semicircular castings, in halves, like rain water guttering, and were then bolted together. I have seen a copy of a letter in which James Watt says, with great delight, that by using Wilkinson's boring machine, he has obtained some engine cylinders that are not more than ¼ inch diameter larger at one end than at the other. This very energetic and clever man had works at Warrington, Bilston, and in the neighborhood of Wolverhampton. His brother-in-law, Dr. Priestley, of Birmingham, the discoverer of oxygen, was born in Cheshire, and afterward went to Birmingham.

William Sturgeon, another Lancashire inventor of note, was born near Lancashire, his father being a shoemaker. Young Sturgeon was apprenticed to the trade, and to escape ill-usage he enlisted in the Westmoreland Militia, and later on was a private soldier in the Second Battalion of the Royal Artillery. When stationed at Newfoundland with his regiment he began to study thunderstorms, lightning, and electricity. The sergeant of his company lent him books, and, according to the late Dr. Joule, who has written a short memoir of him, when a soldier he devoted considerable time to the study of mathematics and the dead languages and optics. He became somewhat of a lithographic draughtsman, and kept up his old trade of shoemaking. When discharged in 1825 he devoted some time to scientific researches and bought an old lathe and taught himself turning. In 1825 he presented to the Society of Arts his first soft iron electromagnet, for which he was awarded a premium of thirty guineas and a silver medal. According to Dr. Joule, Sturgeon discovered the soft iron magnet in 1823, although he did not publish an account of it until 1825.

He also invented amalgamating zinc plates with a film of mercury as now used in the Leclanché and other electric batteries. In 1832 he constructed an electro-motor, the first contrivance to transmit mechanical force by electrical wires. He invented the commutator, and sent a description of it to the Royal Society; but for some reason the memoir was not accepted, and was returned to him by the Society. He afterward published it by subscription. He came to Manchester in 1838, and was superintendent of the Royal Pictorial Gallery of practical science. He hawked the portable magnetic machine for medical purposes at one time, for his poverty was very great. After young Joule left Dalton, Mr. Joule, Senior, consulted him as to what was the next thing to do. Dalton said that by all means he should go and have a course of scientific training with Sturgeon. I obtained this interesting bit of information from a venerable relative of Mr. Joule, Senior, a short time ago.

He contributed to Bradshaw's Manchester Journal, published in 1842. He lectured at the Mechanics' Institution and Salford Lyceum, and lived in a poor way in this district. He started a journal called the Annals of Electricity, and to this journal Dr. Joule contributed various papers. The first Bishop of Manchester, Dr. Lee, Mr. Binney, and the Literary and Philosophical Society in 1850 petitioned the government in consequence of his poverty, and Lord John Russell's government granted Sturgeon £200 and an annuity of £50 per year, which he enjoyed for only fifteen months. He died poor, in 1851, aged sixty-seven, and lies in Prestwich Churchyard.

This great man's life was one perpetual struggle with adversity. He was highly appreciated in his lifetime by men mostly as poor as himself, but we who are blest by his labors may remember him with reverence when we see the electric light or the rapid electric cars; or when we respond to the tinkling of the bell which summons us to use the telephone, for all are evidences of his invention of the soft iron magnet.

The invention of the puddling furnace by Henry Cort, of Lancaster, caused great improvement in the quality of manufactured iron. Previous to the year 1783 no English iron was used for the purposes of the British navy. As much as £35 a ton was paid for Russian or Swedish iron, for English iron was bad in quality, and as a means of removing the impurities from it, the furnace met with immediate and remarkable success. When Cort took out his patent, the best iron came from Sweden. Small quantities were made in England by charcoal furnaces, but the invention of Cort's puddling furnace stopped the importation of wrought iron. The iron-masters willingly agreed to pay a royalty of 10s. per ton. Cort's rolling mills with grooved rollers were also of great service in producing a more uniform bar. The production of iron received a great impetus from his inventions, as it was only 90,000 tons per annum when his invention was introduced; in the course of two or three years it rose to five millions per annum. Ninety years afterward we exported thirty-eight millions in value per annum. Cort died poor, chiefly through unfortunate partnerships.

The steam hammer by Nasmyth is so well known that there is no necessity to describe it. The hammer was designed at Patricroft in obedience to the increasing demands for larger forgings, although uncouth and difficult tilt hammers had been used with steam power before this period. The chief quality of the invention of Nasmyth was the valve that enables the hammer to be brought down on the hot metal with great precision.

The paddle shafts for the steamship "Great Britain" were being made in 1838, and Mr. Nasmyth was requested to consider the dilemma, for no tool was large or strong enough to produce the forgings. Nasmyth at that time brought out his hammer. I remember my father telling me that in 1851 there was one shown in the great exhibition in Hyde Park, and he saw it come down with great force on the top of a gold watch, the blow being regulated with such delicacy that the hammer struck and held the watch so that it could not be moved and did not break the glass. Nasmyth was a Lancashire Scotchman, and came as a young man to Manchester, and the story of his life has been well told by Mr. Smiles in his industrial biographies.

Dr. James Prescott Joule was born in Salford in the year 1818. In addition to having discovered the mechanical equivalent of heat, he was the first to invent electro-welding, and his investigations in electricity generally have been of considerable scientific value; but his great work will always remain the discovery of the mechanical equivalent of heat. His name is placed among the mechanical inventors, for it would have been impossible for him to obtain his results if he had not, with great ingenuity, invented the mechanism that proved the accuracy of his scientific theories.

Prof. Tyndall describes his work with some eloquence. He says: "Those who are acquainted with the details of scientific investigations have no idea of the amount of labor expended on the determination of these numbers on which modern calculations or inferences depend. They have no idea of the efficients shown by a Berzelius in determining atomic weights; by a Regnault in determining expansion; or by a Joule in determining the mechanical equivalent of heat. There is a morality brought to bear upon such matters, which, in point of severity, is probably without a parallel in any other domain of intellectual action."

There is a monument, to commemorate his services, in Manchester, and his name will live for evermore in the classics of science and in the class books of the young engineers and electricians of the world.

Litherland, of Warrington, invented the lever watch in the year 1791. A great trade in chronometer movements had gradually grown up in the neighborhood of Prescott and Warrington, and watchmaker's tools of excellent quality are still produced at Warrington. Although Reid, in his book on clocks and watches, says that it was invented in France, I have compared the drawings in the patent specifications and find that the patent lever watch in its simplicity and utility was invented by Litherland. He also invented a keyless watch, but I am unable to say if it was the first.

The typewriter was first invented by William Hughes, a Manchester man, the first master and governor of Henshaw's Blind Asylum, in 1850. This instrument was originally brought out for the use of the blind. The types striking the paper were made of steel, causing the letters to be indented on the paper, so that they could be easily read when touched by the sensitive fingers of blind persons. This typewriter was somewhat extensively used when first brought out. There is one in the Victoria and Albert Patent Museum at London. Since Mr. Hughes' death the ink roller has been added, and the modern typewriter is the result; but the actual details of the present typewriter may be found in this original invention of the ingenious first governor of the Blind Asylum.

John Ramsbottom's name is well known in connection with the London & North-Western Railway. He was for many years the chief engineer of the company, and he invented the well-known double safety valve for locomotives known by his name. He was born at Todmorden, in the Lancashire end. Most readers are probably well acquainted with the very ingenious arrangement for feeding locomotive tenders with water while the train is in motion. This was the invention of Mr. Ramsbottom.

He also made many improvements in looms, and invented the weft fork stopper for weaving. The weft fork is a simple invention, but of immense value to the power loom, for its automatic action stops the loom when the weft breaks, and has much reduced the cost of production.

I think his condenser lubricator is one of the most ingenious inventions about a steam engine. Its simplicity consists in filling a brass cup with oil; steam is admitted which condenses, and a drop of water descends from the top of the cup into the oil, displacing the same amount of oil, which then slowly passes into the cylinder or steam chest. When the cup becomes full of water, this is drawn off and replaced with oil.

British commercial eminence owes much to these Lancashire inventors, whose work I have endeavored to describe, and whose genius has changed the entire face of Great Britain and increased British national prosperity. Is it not very pitiable, when we consider their melancholy history, that most of these benefactors have been martyrs, that the communities they most benefited brutally ill-treated them from the time of Kay, of the fly shuttle, whose invention consolidated the Lancashire cotton industry, on to Richard Roberts, the inventor of the self-acting mule, whose buildings were defended by two arsenals of guns and pikes?

Let us for a moment consider our present commercial position, and in doing so remember this, which I desire again to emphasize, that we are the last comers, that we have had possession of our chief industries, as leaders, for only little more than half a century. The Lancashire manufacturers at the end of the eighteenth century bought their cotton in the chief city for the raw material and finished goods, Barcelona, and not in Liverpool. We have been makers of bar iron for little more than a century; before that period the Continent produced superior metal.

The opposition to improving machinery in the silk trade—machinery, by the bye, of our own invention, with the one exception of the Jacquard loom—has driven the bulk of the trade to the Continent; indeed, the silk weavers of Lyons are better paid than ours; they receive higher weekly wages, and this we have on the authority of Sir Thomas Wardle, who attributes the decay of our silk manufacture to neglect in not adopting labor-saving mechanism. We had a large silk manufacture here at one time, and when I was a boy there were many mills in Manchester and Salford. At present the tools that Lancashire men have invented are being refined by Germany and the United States, and because of the freedom of labor there, in many cases, they are used to better advantage than they are in this country, where restrictions, limiting output, are imposed by labor combinations.

I can specify goods made abroad that are being sold in Manchester and London that it is nearly impossible to make in this country and sell at the same price, and yet the tools that are used to produce them were invented by men of Lancashire.

Our stupid patent laws are doing our industries a great amount of injury. They were originally created to encourage and reward genius in this country and to stimulate British trade, for which see the preamble of patents of the time of Charles the First; but we know that if a foreigner takes out a patent here, he can manufacture his goods abroad and send them to this country, as in the case of aniline dyes and other chemical products. A change in the laws in that respect is imperative, and would be of great benefit to the chemical and other industries of Great Britain. All British patents should be for goods made in Britain and to benefit British industry; otherwise the grant of a monopoly to attack us is a farce and cannot be defended.

The Manchester Ship Canal has done something for the export trade, but rings have been created that give the foreigner the use of British ships at a cheaper rate than our own citizens. For instance, last year cotton goods were sent from New York to China, calling at Liverpool, at 27s. 6d. per ton, while Manchester men paid 55s. by the same boat. There is a cure for this. One is that no government mail subsidies should be given to ships that thus place us at a disadvantage.

In steamships we need not despair. Great Britain is still mistress of the seas. I think we may be satisfied that we produce them and are unrivaled in price and quality. There is no necessity for us to imitate the daughters of Zion and sit by the waters of Babylon lamenting the past glories of our country. Let us just examine the figures for one moment. Mr. Baker, the president of the Atlantic Transport Line, in a report some time ago, dealt with the cost of shipbuilding in Great Britain and America, and he compared the building of two ships by Harland & Wolff, of Belfast, with two ships from the New York Shipbuilding Company, of Camden. The English steamships cost £292,000 each, and those built at Camden, similar in size and tonnage, cost £380,000 each. Two smaller boats built in America cost £150,000 each, and similar boats were obtained from Harland & Wolff, one costing £110,000 and the other £100,000.

If we compare the total tonnage of steamships of the world it amounts to 22,000,000 tons, of which Great Britain owns 12,000,000 tons. The sailing vessel figures are somewhat similar; of 5,000,000 tons Great Britain owns nearly one-half. Our position in other respects is well maintained.

In education, a stern chase is a long chase, when ignorance is the enemy. Ignorant, well-meaning piety has much impeded scientific teachings; but public opinion now demands that we must rationalize education and stop the great waste of energy in the schools of this country. Complacency is the bane of Englishmen; but none can be vain who compares the industrial education given in the United States, in Germany, and even in Hungary, with much of the aimless work that we call education in Great Britain.

Let us not blame workmen overmuch for the decay of certain industries, for some of our handicraft trades are getting old and we do not specialize as some of our competitors do. One machine works cannot make all things cheaply in small quantities. This difficulty must be surmounted by that system and division of labor that has been so successful in the cotton manufacture, and which exists to some extent in the manufacture of looms, for a Lancashire loom is the cheapest machine in the world. This system is also successful in the manufacture of British sewing machines, which are made here quite as cheap, or cheaper, than they are made abroad.

The clock trade of the United States is a triumph of organization and an example of dear labor and automatic tools producing cheaply. The pioneer was Chauncey Jerome, who went from the Black Forest to the States. He designed sheet brass clocks, made like the wooden ones of Germany; he ordered the wheels and frames to be stamped in Birmingham, and, after putting them into cases, sent them back to Great Britain and beat us in price.

We have seen how industries have moved from place to place in Europe, and that cunning, dexterity, industry, enterprise, and cheapness all influence the change. Our commercial culture is no longer being neglected. Noble technical schools are sharpening the wits of labor, and education is being rationalized. This must strengthen our position, for those who have compared our schools with those of our trade rivals feel dismayed at our deficiencies; indeed, all our courage and ability will require scientific guidance if we are to maintain our position.

The future should be less difficult than the past; indeed, it should be easier for those who follow us, for we inherit pluck and the art of overcoming difficulties, precious hereditary qualities that are recorded in the history of the world's explorers, and which have made our axes ring in Canadian forests, sent our ships to unknown seas, and made the sound of British

steam whistles heard beyond the sacred Temple of Isis, on the banks of ancient Nile.

Material progress is not the only reward, not the only product, that we receive from the labors of our men of genius, from our great inventors, for the results would be of little value if they did not lighten the burden of labor. We know and have faith that the chief achievements of the harnessed serfdom of Nature's forces temper the serfdom of man and create some leisure from the hours devoted to his mere physical needs for the higher and nobler pursuits of intellectual citizenship.

Napoleon said: "The tools to him that can handle them" (*La carrière ouverte aux talents*). He also said that the steamboat, in his opinion, "is destined to change the entire face of Europe."

Lancashire men have changed the face of the world and altered the map, and also the class books of the students of all the seats of learning throughout the globe. Dalton discovered the law of the conservation of the chemical elements, and Joule discovered the law of the conservation of energy. In the eloquent words of Dr. Osborne Reynolds: "It is to the memory of Joule that mankind owes its gratitude for the grandest generalization in the universe—the complete mechanical foundation of physical science."

The laws of the Manchester prophet tell us that all investments of pluck, of energy, of hard work, and loyalty bring ample recompense, that work done squarely and unwasted days in due time produce rich harvests.—Cassier's Magazine.

IRRIGATION.*

IRRIGATION has been practised in America from time immemorial by the town-building Pueblo Indian tribes inhabiting portions of New Mexico and Arizona. Their ancient canals may still be traced across the broad valleys, through which are scattered the almost innumerable ruins of community dwellings. On the mesas of southwestern Colorado and adjacent portions of Utah, Arizona, and New Mexico are found the wonderful cliff dwellings, and in the little valleys near these may be seen ditches which were in use perhaps a thousand or more years ago.

The descendants of these Indians still utilize some of the lands which were tilled by irrigation at the time when the Spaniards first came from the South, and they practise many of the primitive customs of their ancestors. Contact with the white man has done little to change their methods, and it is probable that they taught the first white settlers in those regions how to cultivate the ground successfully.

The Mexicans of mixed Spanish and Indian origin gradually extended their settlements from the south, and through necessity practised irrigation. Their small ditches have been built along the Rio Grande as far north as Colorado and the tributaries of the Arkansas River. The early missions of the Pacific coast also practised irrigation, and in Southern California particularly are to be found the ruins of substantial dams and headworks built of masonry and constructed by Indian labor.

The first systematic application of irrigation in the arid West by English-speaking people was made by the Mormons, who, driven out of Illinois and Missouri, took their flight westward into the unknown desert regions, and finally, after great privation and suffering, were compelled, largely by necessity, to stop on the shores of the Great Salt Lake. The soil was so barren that crops could not be raised by ordinary means, and, forced through fear and privation to adopt new and extraordinary devices, they turned the waters of the little canyon streams upon the ground where Salt Lake City now stands. After many years of meager success or disheartening failure, they succeeded in mastering the art of irrigation and under the wise rules of Brigham Young, limiting the size of irrigated farms, the Mormons have become a prosperous people.

At about the time when the Mormons were building up the state of Deseret, now Utah, the gold miners in California were building ditches for placer washing, and were using water from these ditches for irrigation. The results obtained through the use of these ditches, and also by those of the old missions, attracted public attention, and irrigation slowly developed, at first as an adjunct to mining. With the stoppage of hydraulic mining in many places, consequent upon the passage of the antidébris law, the ditches built for mining were either abandoned or used exclusively for irrigation. Many of them have been enlarged and have now even greater value than in the old days of mining excitement.

A notable epoch in the development of the West was the founding of the colony in northern Colorado, named after Horace Greeley, its chief promoter. Although unfortunate in its early years, the colony succeeded in learning how to control and utilize the waters of Cache la Poudre River for irrigation. The success ultimately attained by the Greeley colony, and the wonderful results shown by the Mormon communities, which have spread from Utah north into Idaho and Wyoming and south into Arizona, have attracted public attention and have greatly stimulated the colony idea. As a consequence, many organizations have been formed for the purpose of bringing people in large bodies from the Eastern States, and even from Europe, and placing them upon small farms located near each other and supplied with water from a common ditch. Individual settlers also have sought opportunities for bringing land under cultivation by artificial watering, and thus, at many widely scattered points, irrigation has been introduced.

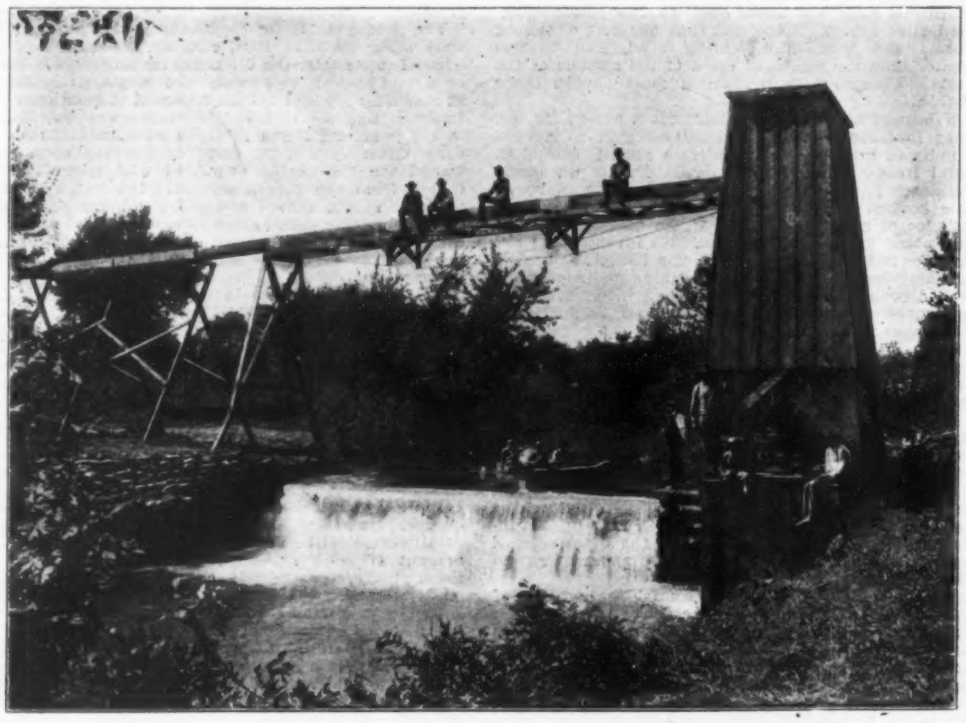
The Mormons entered Salt Lake Valley in July, 1847. At that time there were probably not more than a few hundred acres irrigated by Indians, Mexicans, and the California missions. The Union colony settled at Greeley, Colo., in 1870, twenty-three years after the Mormons had begun irrigating. There are no statistics concerning the area irrigated in 1870, but it is probable that in that year there were not over 20,000 acres under irrigation in the whole United States. From 1870 to 1880 was an era of rapid development of small ditches, constructed by individuals and associations of farmers. At the end of that period there were probably 1,000,000 acres under irrigation.

In the decade 1880 to 1890 occurred the "boom" of speculative enterprise in irrigation canals. Large sums of money were obtained for irrigation works by the sale of stocks and bonds, and great enterprises were projected, canals of upward of 100 miles in length being planned and in some cases built. Nearly all of these failed of financial success, and although they have aided in the extension of irrigation, they have not enriched the investors.

The Eleventh Census was the first to devote attention to irrigation, and the statistics obtained show that in 1889 there were 3,631,381 acres irrigated on 54,136 farms, with an average irrigation area of 67 acres. During the following decade, the irrigated acreage doubled in extent. This has been due rather to the extension and enlargement of the many canals existing in 1889 and to the more complete practice of irrigation on the lands then under ditch than to the construction of new and large systems of irrigation.

A relatively small part of the West is under irrigation. It must be remembered, however, that only a small portion of the Western States and territories is as yet in private ownership or included in farms.

There is great need of systematic study concerning the actual effect which the water has upon the soil and



PUMPING WATER WITH TURBINE WHEEL AT COLUMBUS, NEBRASKA.

IRRIGATING ON TERRACED HILL.

* From Twelfth Census.

upon the plants. Where the supply is abundant the quantity of water used is generally far in excess of that theoretically demanded by, or actually beneficial to, the crops.

Irrigation properly conducted means intensive farming with great care in the application of water, followed by thorough cultivation of the moistened soil. In no sense is it a lazy man's way of farming. Different plants require different amounts of water. Each crop has different needs, and the practice of irrigation must vary accordingly. Not only the character of the plant, but also the quality of the soil must be considered. Certain soils, such as sand and gravel, receive and transmit water with great rapidity. Others, like clay, take water slowly and hold it with great tenacity. Thus the manner and time of irrigating will vary according to the ability of the soil to hold and supply water as needed. If the moisture escapes rapidly, as it does from sandy soils, the plant after a few days begins to droop from lack of water. On the other hand, if the soil is very compact, it may become water-logged, so that air cannot penetrate the interstices, and the plant suffers from drowning.

IRRIGATION BY CHECKS IN SAN JOAQUIN VALLEY, CALIFORNIA.

Another factor in the production of crops is the form of vegetable life known as nitrifying organisms. These, in the presence of air and moisture, manufacture food for the plant. A certain amount of water is needed for these nitrifying organisms, but too much water stagnates and destroys them.

There is in irrigation a benefit of great value beyond the mere moisture. The fine silt brought in suspension by the water is deposited upon the surface of the soil, making a light, rich covering, which protects the young plant and supplies it with food. This sediment is of greatest value when the source of the stream which carries it is from forested areas with decayed vegetation; on the other hand, a stream from the bare mountain slopes may bring fine quartz grains of little value to the land. The artificial control of silt is a reproduction on a small scale of the method by which nature has made rich farm lands. The rivers have brought the fine material from the higher slopes and spread it out, filling the old lake bottoms or covering the flood plains of the rivers.

Thus it is, when sufficient water to saturate the soil is regularly applied to the land, its productive qualities are maintained in many cases without impairment for an indefinite period, and soil, apparently poor and worthless, produces crops which compare favorably with those grown on the richest soil of the humid region.

Artificial fertilizers, when required, can be used perhaps more economically and effectually by allowing the water to act as a transporter, carrying the fertilizer either in suspension or in solution to the point where needed. That in some cases no other fertilization is necessary, is shown by the continued fertility of small farms of the Mexicans along the rivers and streams of New Mexico, which have been cultivated for hundreds of years by use of the muddy waters of the Rio Grande.

SURFACE WATERS.

The waters of surface streams supply over 90 per cent of the irrigated land. Of less relative importance are the underground waters obtained by flowing wells or by pumping.

The streams within the arid region of the United States have their sources high amid the rocky, or forest-clad slopes of the mountains. Usually at one point or another they meander for a time through upper valleys or parks, whose summer verdure is in striking contrast to the sunburned plains below. Leaving these the streams enter rocky defiles or narrow canyons to emerge upon a narrow lower valley, and receiving tributaries on the way, finally pass through the foothill region and out upon vast fertile plains. At about this point a general transition takes place in the character of the channel, which, from a rocky, torrential, or gravely stream bed with rapid fall, broadens to a shallow, shifting, sandy channel, in which the stream, dividing and subdividing in times of low water, finally by imperceptible degrees loses itself. In times of flood the water may fill the broad, sandy waste, and after a few days force its way far out to join some lake, or to flow into some perennial stream, finally reaching the ocean.

If the stream channel were like an iron pipe or conduit, in which the water, once received, must pass along until discharged at determined points, the consideration of water supply would be comparatively simple. It would be assumed that whatever water came into the pipe must come out at some point, or, in other words, that the quantity to be dealt with would be constant. This, however, is not the case in nature.

There is great irregularity in the volume of a stream at different points in its course, due to seepage or percolation. Under natural conditions a stream gradually increases in volume in its upper course, both by tributary surface streams and by percolation, while in the lower and drier part of the basin the loose or unconsolidated soils draw away some of the water until it is taken up into the atmosphere. Direct evaporation from the surface also diminishes the volume of streams in their lower courses, but this factor is relatively small.

There is thus a point, usually at or near the lower foothill region, where canals and ditches can be most economically constructed to carry water to the edge of the lower plain. This locality has other conditions favorable to successful agriculture by irrigation. Protected by foothills, its climate is often better than that of regions farther out upon the plains; the winds are not so severe, and the frosts do not come so early in the fall nor linger so late in the spring. If physical conditions only are to be considered, a proper distribution of efforts at such places would result in the largest and best utilization of the vast extent of public lands. Under the gradual development of agricultural interests, however, settlement has not taken place so as to produce the greatest good for the greatest number, partly on account of lack of knowledge of these facts.

It is not the main or trunk streams in their lower courses which are of chief importance in the development of the arid country, but rather the upper, smaller tributaries. The main streams are too large to be controlled by ordinary hydraulic works for irrigation, and they have, as a rule, attained such gentle grade that they have little industrial value except possibly for navigation. In the upper courses, where the streams are small and descend rapidly with falls and cascades, or with swift waters flowing downward at the rate of several feet for each mile of the channel, it is possible to erect structures at certain points by which power can be developed or the waters taken out by gravity to the lower lying fertile lands. Headworks can be placed more easily along the banks of smaller streams, or dams built across their beds, raising and controlling the waters.

The rivers coming from the mountains fluctuate widely in their flow, delivering during certain days or weeks volumes of water many times the average, or falling in late autumn to a discharge so small that the streams become almost worthless for industrial purposes. Not only do the rivers change from season to season, but in successive years there may be a wide variation. It is this erratic character of streams which makes difficult, expensive, and often profitless, the work of utilizing water resources.

There are limits to the quantity of water which, under a combination of circumstances, may be discharged at any point. Although there is a certain permanence in the factors which make up the climate of any locality, yet the resultant of these as shown in the river flow, departs widely from the average. Taking four prominent factors, viz., the total amount of precipitation, the rate at which the rain falls, the temperature, and the wind movement, it is evident from inspection of tables that these vary slightly from the average in each season. When one of these departs from the normal, the river flow may or may not be affected to the same degree. Twice the usual rainfall may result in increase in river flow or not, according as the other factors modify the effects. It is evident also that with a number of factors, each independent of the other, the combinations will be numerous, and while the greater part of the results produced by this combination have a narrow range, there will be some far removed from the average.

Every body of water increases and decreases each year by a notable amount, the quantity of water following the changes of the season. Observations carried on through a number of years show fairly well the percentage of change from month to month and afford means of predicting the probable quantity for short periods. When, however, the amount of water in a lake or river during any one year is compared with that of the years immediately preceding, it is usually found that there is a gradual, progressive change in one direction or the other. This continues for some years—it may be three, five, ten, or any number—and is followed by a change in the other direction, which may continue for an indefinite length of time. This is known as the nonperiodic fluctuation, in distinction from the seasonal change. In addition to these there are floods which can not be classed under either designation.

The range in nonperiodic variation is a matter which can not be predicted, and one in which experience furnishes little guidance. Starting with the total quantity discharged in one year, it may happen that the total flow for the next year was twice as great and for the succeeding year three or four times as much. As is well known, the quantity of water increases with far greater rapidity than does the height of the stream, so

FLUME CROSSING LITTLE ROCK CREEK, SOUTH ANTELOPE VALLEY IRRIGATION SYSTEM, CALIFORNIA.

that the volume of a stream may be doubled without general attention being directed to the fact. In arid regions changes in volume, negligible in other parts of the country, are apt to be noticed and commented upon. Apprehension has been aroused by the gradual decrease of certain streams in Colorado and adjacent States, which from about 1885 appear to have diminished in volume. In a country where the water supply is always

deficient any decrease is a most serious matter, and might be taken as arguing the complete disappearance of water from the region, if it were not known that streams in other parts of the country have fluctuated in the same manner and returned to former conditions.

There are, however, certain artificial causes tending to modify stream flow. It is possible that the destruction of forests causes diminution in the flow of streams draining mountain areas, and that the mountains must be reforested in order to assist in regulating the volume of the rivers. On the other hand, when for a period of years as from 1882 to 1885, the available water supply of a district increased, as it did on the Great Plains, trivial causes were assigned and it was argued that the progress of civilization had induced climatic changes. Acting upon this theory, thousands of persons were induced to settle in an almost arid region, the result being that when the water supply returned to its former condition, crops were lost year after year, and these unfortunate people were reduced to the verge of starvation.

It is common for persons to point to the fact that years ago water was regularly found in certain streams, or to assert that floods were never so destructive in former years as at present. Many of these statements rest merely upon individual recollection, and careful measurements show that a great part of them are incorrect.

STREAM MEASUREMENT.

The unit of measurement used to express the quantity of water flowing in a stream is dependent upon the time considered. The cubic foot per second, or second-foot, is commonly used to express volume of flow, the gallon, however, being largely employed by engineers and others having to do with city waterworks.

A small stream flowing in a conduit 1 foot wide and 1 foot deep has a sectional area of 1 square foot. The volume of this stream will vary proportionately to the velocity with which the water flows through the conduit. This velocity is most conveniently expressed, as above noted, in the rate per second, the foot being used as the unit of distance. If, for example, the water is moving at the velocity of 3 feet per second, it follows that there is a flow of 3 cubic feet per second. The measurement of the flow of a stream consists, therefore, in obtaining its width, depth, and velocity. As streams occur in nature, these quantities are not always precisely bounded, and considerable judgment is required in assuming the limiting points.

The width and depth of a stream can be readily found by measuring lines or sticks, but the third factor, that of velocity, requires additional apparatus, as the element of time must be noted. All portions of a stream do not move at the same rate. Each particle moves along a path of its own, usually with more or less circular or gyratory motion. In the center of the stream, or where the water is deepest, it moves more rapidly than near the shore, while the place of greatest motion is about one-fifth of the distance beneath the surface, as at this depth the water is least impeded by friction and surface tension. Toward the sides and bottom the rate of flow gradually diminishes, the speed being governed by the roughness of the surface, bowlders, or projections causing eddies and setting up disturbances, which retard the forward motion.

The simplest way of obtaining the rate of flow is by means of small objects floating upon the surface. A course of 100 feet in length is laid off along a stream. A floating object is thrown into the stream at the upper stake, and the exact time required for it to traverse the course noted. If twenty seconds are required, then the speed of the floating object is 5 feet per second. If the first float follows the center of the stream, others can be tossed in so as to travel in lines intermediate between the center and the banks on each side. If these are well distributed across the stream, the average will be approximately the surface flow.

It is assumed that the water as a whole usually moves at about 0.8 the average surface velocity. Taking the surface flow as 4 feet per second, it is necessary, therefore, to multiply this surface flow by 0.8, giving an average rate of flow for the whole stream of 3.2 feet per second. If the width be 10 feet, and the average depth 3 feet, the area or cross section is 30 square feet, and the rate of flow 3.2 feet per second gives a volume of 96 second-feet.

The most common device for obtaining velocity is the current meter, an instrument which consists essentially of a small mill or wheel held at a given point in the water and caused to revolve by the stream, whose velocity determines the speed of revolution, which may be recorded by a dial, or registered at a considerable distance by electrical transmission. In rivers and creeks of ordinary size it is usually sufficient to make observations at intervals of 10 to 20 feet horizontally. In deep streams it is necessary at each of these localities across the section to observe the velocity just below the surface and at intervals of from 2 to 5 feet to the bottom. All parts of the cross section may be reached by suspending the instrument from boats, or from bridges, timbers, or cables extending across the stream.

There are other methods which arrive at the total flow by the application of principles and formulæ derived from experiments. By these methods the velocity of water is estimated as it passes over or through some regularly formed channel or aperture, as a weir, which is a dam so constructed that the water passes over it or, more usually, through a section of it with uniform current and gentle fall.

Careful experiments have been made with weirs of various forms and dimensions to determine the law of velocity of the water flowing through openings of given sizes and shapes. From the facts thus obtained formulæ have been derived by the use of which the volume of water flowing in a stream may be measured with a very considerable degree of accuracy, even to within 1 or 2 per cent of the true volume.

For measuring or apportioning water in a canal, there are in use a number of devices of simple construction, roughly made and built with little attempt at accuracy of measurement. The irrigator receives usually a certain proportion of the water in the ditch, for the determination of which dividing boxes or flumes are made.

In apportioning the water to be distributed from the canals into the ditches, the miner's inch has been widely employed as a unit, because many of the earlier ditches were built by miners and quantities of flowing water were ascertained by their standards. The miner's inch, however, is not a definite quantity. Several of the Western States have attempted to define it by statute, but the laws lack uniformity and permit notable variations in delivery from the measuring boxes. Engineers have adopted as a unit the cubic foot per second, or second-foot. Attempts have been made to revise the State laws so as to define the miner's inch as the fiftieth part of a second-foot. By so doing a measure is obtained which does not vary according to the construction of the measuring device. In the eastern part of the arid region the miner's inch is, as a rule, larger than in the western part. The Colorado miner's inch is about a fortieth part of the second-foot. In making computations, the California miner's inch or one-fiftieth of a second-foot is convenient, and for this reason has been generally employed.

DIVERSION FROM THE STREAM BY DITCHES AND CANALS.

The water used in irrigation is for the most part taken from the river or creek by natural flow or gravity. The cost of lifting or pumping water is usually too great in proportion to the value of crops raised to permit the general use of pumps. Most irrigation systems must be planned with reference to the relative altitudes of the lands to be irrigated and the source of water. The valley lands are lower, in part at least, than the water farther up stream, and if a canal or ditch is begun on a gentle grade above the head of a valley and carried out along the banks of the stream, it can be kept at a higher elevation than some of the arable land. Water will flow rapidly in a ditch having a fall of 2 feet per mile, and the stream supplying the ditch may be falling at a rate of 12 feet per mile. At the end of the first mile the water in the ditch will be 10 feet above that in the river, and at the end of the tenth mile will be 100 feet higher, and will thus cover land which is less than 100 feet in altitude above the stream at this locality.

Dams and Headgates.—It is usual to construct some device at the upper end of each ditch or canal by which the amount of water entering from the river can be regulated. Without this, flood waters would fill the ditch beyond its capacity, and would overflow and wash away the banks. In times of low water, also, the stream may fall to such an extent that it must be raised somewhat and forced into the ditch, and at all times it may be necessary to regulate the flow in order to apportion the water fairly to all concerned. In the case of the simplest ditch, a small dam of brush and stone is built diagonally into or across the stream bed as the water becomes low in summer, and this is made tight by means of sod and earth. Such a dam is washed away during high water, but can be replaced at small labor and expense. More permanent dams are sometimes built of timber, or masonry, as in the case of works constructed by large associations or corporations. These dams, intended to resist the destructive action of floods, must be solidly constructed and carried down to bedrock.

The headgate or regulator of the canal is placed at the end of the dam, consisting of a stout framework firmly bedded in the earth or rock and containing one or more openings, each of which can be closed by a gate sliding vertically. The water enters under the gates, the quantity being controlled by raising or lowering them.

The water in the canal is apportioned to the ditches by a method of division in common use.

The water is divided by a center partition, which in some forms of division may be so adjusted as to divert different quantities of water. At a short distance beyond the center is a horizontal bar, raising the water slightly, so as to insure a fairly uniform condition at the point of division.

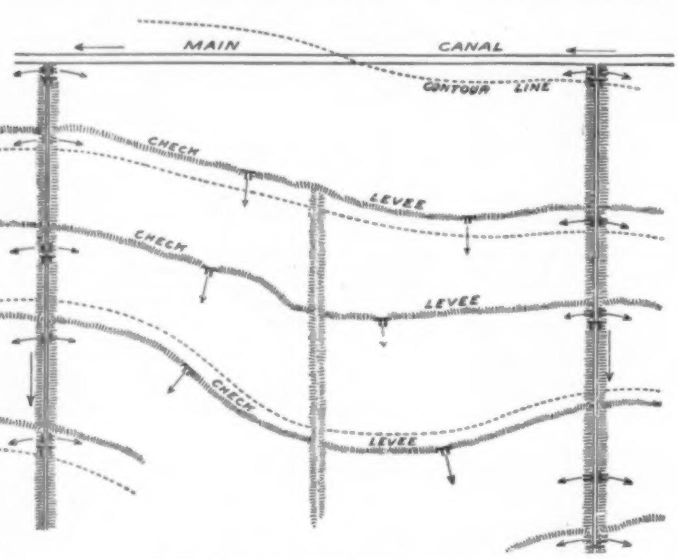
PLANNING AN IRRIGATION SYSTEM.

In laying out an irrigation system it is usual to begin at the highest point to be irrigated and to run a trial line to the water surface across lands where ditch construction is most practicable, and on a slightly ascending grade, a foot, more or less, to a mile. Rocky obstructions and depressions are avoided as far as possible by detours in the route.

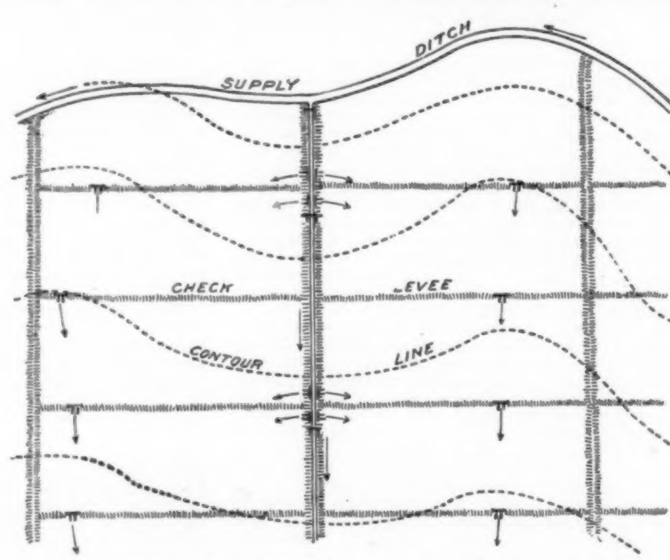
In planning the larger canals and irrigating systems bringing water by gravity, it is necessary to consider carefully the slopes to be given the conduits. This is especially true where a broad valley is to be irrigated from a stream whose upper course is only a few feet above the general level of the land. If the grade is steep it will be necessary either to lengthen the canal or to take water only to the lower land, leaving the higher portions of the valley dry. If, on the other hand, a very gentle grade is given, the water will flow slowly and a very large canal must be built to carry the necessary volume. Of importance equal to the relative height of the source of the water and the land to be irrigated, are the effects of the slope of the canal upon the velocity of the water and the consequent cutting or filling of its channel. With a steep grade, the water moves with such rapidity as to pick up and carry along fine particles, and with increasing velocity larger and larger grains of sand or pebbles are moved, eroding the channel and carrying the loose material to points where it may be a source of annoyance or injury.

The power of a stream to cut its bottom and sides increases very rapidly with higher speeds. Experiments indicate that by doubling the velocity of the stream its power of erosion is not merely doubled, but is increased sixty-four times; thus a very slight change in the rate in which water flows makes a very great difference in its action as regards carrying or depositing loose materials. When the speed of water, carrying silt, sand, or gravel, is reduced in any way, the heavier particles are immediately deposited. A mountainous or torrential stream entering a pond or reservoir deposits at once the bowlders or gravel, then the sand, and finally the clay or silt. A similar condition occurs in a ditch or a canal. Water from the river is sometimes muddy, especially in times of flood, and on entering the canal, if the velocity is reduced at any point, some of this material will settle and form a deposit along the sides or bottom.

A stream of uniform volume tends to fill depressions along its course and to wear away projecting points or obstructions. If, for a given volume of water, the cross section of a portion of a canal is too large, the velocity will be checked and sediment deposited, reducing the size of the channel until this reduced area reacts by causing a slight increase in the velocity of the water. The cost of removing the sediment which obstructs the free flow is often a notable item in the expenses of a canal. For cleaning very large canals and for enlarging them dredges have been used. These float along the canal as the material is dug out from the bottom and sides. By means of such a device a canal can be cleaned while in use; otherwise it is necessary to shut the water off and allow the bottom to become sufficiently dry for horses and men to work in it. If, on the other hand, the grade of a canal is steep, some means of preventing erosion of the sides and bottom must be adopted; otherwise damage would result in several ways. The erosion of the bottom gradually reduces the level of the water in the ditch, and the material carried along is finally deposited at some place where it may choke the ditches or cover the fertile land.



FLOODING IN CONTOUR CHECKS.



FLOODING IN RECTANGULAR CHECKS, NOT LEVEL.

The removal of fine material leaves the bed open and porous, permitting the water to escape by percolation. The losses in this direction are prevented where the conditions are such that a small amount of silt is deposited and remains, filling or cementing the minute openings through which water would otherwise be lost.

A considerable slope can be used for small ditches, since the volume of water is not sufficiently great to move the large particles of sand and gravel. For example, on the farm lateral, carrying 1 or 2 second-feet, a fall of 50 feet or more to the mile may not be excessive, the velocity being retarded by the relatively great friction. On the other extreme, a large irrigation canal carrying 1,000 second-feet may be in danger of injury if a grade of much over 6 inches to the mile is given it.

As a general rule, it may be said that conduits of this character built in common earth should be so proportioned as to have an average velocity of a little less than 3 feet per second, or 2 miles per hour, when carrying their full capacity. It is necessary, therefore, to take into consideration the amount of water to be carried and from this deduce the size and shape of the cross section of the canal or ditch in order to obtain the desired velocity. Many of the older irrigation works have been given an excessive grade through fear on the part of the builders of getting too little fall. Some of these grades are as much as 50 feet to the mile, giving a velocity to the water of 5 feet per second, washing the bed of the channel and leaving only a mass of cobbles. The seepage through this material, even though the water is flowing rapidly, has been known in one instance to be over 20 per cent of the total flow in a course of 4 miles.

The shape of the cross section of a canal depends largely upon the character of the surface soil. In light or sandy soil, where the earth is easily eroded, very gentle side slopes are given, while in harder materials the side slopes can be steeper.

When the fall of the canal is so great that it is impracticable to allow the water to flow freely down the slope, devices known as drops are introduced. These consist of an arrangement whereby the water can drop to a lower level without injury to the canal. The force of falling water is very great and rapidly digs out earth and gravel, so that wherever possible the drops are made with the fall upon solid rock. Such cases are rare, and to take up the force of the water it is usual to provide what is known as water cushions. The stream falls into a pool of sufficient size and depth for the eddying or boiling of the water to take up and dissipate the erosive effect.

These drops are usually built of planks, with a sharp overfall edge, and a low dam or obstruction below the fall in order to maintain the pool. Occasionally they are made in the form of an incline, with a pocket at the bottom to break the force of the falling water. These drops are expensive to build and difficult to maintain, because of the rapidity with which the timbers decay and the wearing action of the water, which constantly tends to cut exposed portions.

The earlier canals, being usually of small size, were built with heavy grades. When the canals have been enlarged, the increased volume has attained excessive velocity, and thus it has been necessary to introduce many of these drops.

In localities where frosts do not occur to any considerable extent, and where water has greatest value, experience has shown that it is desirable to line the ditches and canals with concrete or cement, reducing the loss by percolation, and making the channel so smooth that the water moves rapidly even on slight grades. Often it is possible to trim the banks of the ditches to a uniform surface, and this is found to be sufficiently firm to serve as a foundation upon which to put a layer of cement mixed with sand and having a thickness of from three-fourths of an inch to $1\frac{1}{2}$ inches. Where the bed and banks are not firm, it is necessary to pave or revet them with small stone, and then place upon this a coat of concrete made of small gravel and sand. The economy of water resulting from this careful construction has been found to be sufficiently large to justify a considerable outlay.

The pioneer irrigators in planning a ditch use a straightedge or board a rod long (16.5 feet), on one end of which is a block projecting one-half of an inch or an inch. When this board is placed horizontally, the lower projecting point will thus indicate a fall of one-half of an inch or an inch to the rod. By this means points are determined at intervals of a rod where stakes may be driven into the ground, marking out the course of the ditch upon a slightly ascending or descending grade, according as the work is begun from the lower or upper end.

The ditch having been staked out in this manner or by means of surveying instruments, a furrow is plowed along the course and the earth thrown out by shovels or scrapers. Rocks may be blasted away and depressions filled, or crossed by means of wooden flumes. As far as practicable, however, ditches are carried into and around gulches or depressions in the surface of the ground in order to avoid building these wooden structures, since they decay rapidly and are sources of considerable expense.

For the purpose of digging large ditches or canals, a number of farmers usually combine, forming an association, which may be incorporated. In a few instances large works have been constructed by corporations with outside capital, but as a rule these have not been financially successful, and development is not continuing along this line.

Flumes and Wooden Pipes.—It is necessary in the construction of nearly every ditch or canal to take water across a depression at some point in its course. This is usually done by means of a flume or long box, usually rectangular and supported above the ground by a frame or trestle of timber or iron. Such flumes are often used across rocky ground where it is impracticable to dig a ditch. This is particularly the case near the head, where the water, after being taken from the river, is often carried through a narrow, steep-walled canyon. Here the foundation for a flume is prepared along the rocky cliffs, supports being devised to suit the inequalities of the ground.

A better, though more expensive, type of flume is that having a semicircular section. These flumes are built of narrow planks or staves laid side by side and held in place by iron bands run around the flume, joined by nuts and threads by which the bands can be drawn up and the staves brought together. In crossing very deep depressions it is necessary to have a correspondingly high trestle in order to carry the flume across on grade. Such high trestles are expensive and liable to destruction from storms. In their place there have been built inverted siphons, or wooden stave pipe. These pipes are similar in construction to the semicircular frame of narrow plank, carefully planed to a given dimension, and held in place by circular iron bands or hoops.

METHODS OF IRRIGATION.

The methods of irrigation practised in various parts of the United States differ with the climatic conditions and soil, and especially with the early habits or training of the irrigators. The methods of conserving and applying water have been improved under the stimulus of modern invention, although there has been little if any scientific or well-considered information available.

Water is applied to the irrigated field in three ways—by flooding, by furrows, and by subirrigation.

Flooding.—Flooding is done by the check system and by wild flooding. By the latter process the irrigator turns the water from a ditch over a level field and completely submerges it. Perfectly level fields are, however, comparatively rare, and the first step in primitive agriculture by irrigation has been to build a low ridge around two or three sides of a slightly sloping field, so that the water is held in ponds. These low banks are commonly known as levees or checks. In construction they are frequently laid out at right angles, dividing the land into a number of compartments. Water is turned from a ditch into the highest of these compartments, and when the ground is flooded the bank of the lower side is cut or a small sluiceway opened, and the water passes into the next field, and so on until each in turn is watered.

This flooding in rectangular checks is practised most largely by the Chinese gardeners and by the Mexicans living along the Rio Grande. The banks are thrown up by spade or shovel, and the ground between the banks is tilled with a heavy spade or mattock. Water, when had in abundance, is turned into these checks, and the quantities used are often extraordinarily large.

Many of the early settlers in the Southwest imitated the Mexicans, or employed them as laborers, building checks upon the same general plan, but usually inclosing more ground. Fields from 1 up to 20 acres or more in area have been leveled and surrounded by low levees of from 1 to 2 feet in height and 5 to 10 feet in width. These are made relatively wide at the bottom, in order that the slopes may be gentle, so that mowing machines can be driven over them. Rectangular fields are connected by gates set in the levees, so that water can be turned from one field into the other without cutting the banks.

A better method of procedure with these beds is to let the water flow through the upper one until the lowest is covered to a depth of about 3 inches, then obstruct the opening to this bed and permit the water to accumulate in the next square above and so on, filling each in succession from the lowest to the highest and allowing the water to soak away. It is claimed that by following this course the land receives water more uniformly.

For crops such as tomatoes, sweet potatoes, and chili, which are the most important foods of the Mexicans, ridges are made in the beds in such a form that the water is compelled to flow around and along these until the bed is filled nearly to the top of the ridges. Then it is let into the next bed and the operation is repeated. Instead of turning the water from one bed into another, it is customary to provide lateral ditches in such form that the water can flow into each compartment without passing through the other. In this way washing of the soil is prevented and the amount of water can be regulated to suit the needs of each variety of crop.

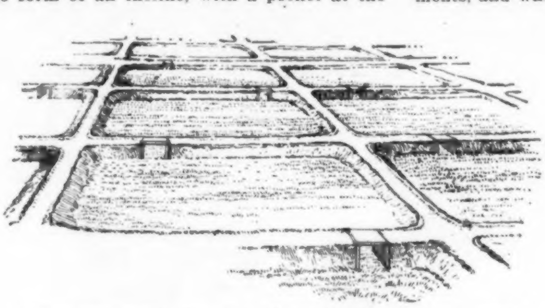
On land that is nearly level, small inequalities are smoothed off by plow and scraper, or by dragging a heavy iron beam across the field, pulling the hummocks into the hollows. A form of wooden drag or buck scraper is shown in the following drawing. This is used largely for leveling soft or sandy soil, being hauled by four horses.

The cost of leveling is usually very great, and it is only for the most valuable crops and orchards that this is done. Where the undulations are of such extent that they cannot be removed by this method, it is necessary, in order to practise check flooding, to adjust the shape of the banks or levees to suit these conditions. Instead of making them rectangular, the levees are built along the slopes to fit the contour of the surface. The canal brings water to the upper side of the field and follows along on gentle grade. Below this, at such distance that a bank which is a foot or two in height will pond the water back to the side of the canal, a ridge is built. The distance of this ridge from the canal will depend, of course, upon the slope of the ground. If very gentle, the bank or levee can be 100 feet or more away, while with steeper slopes it must be nearer.

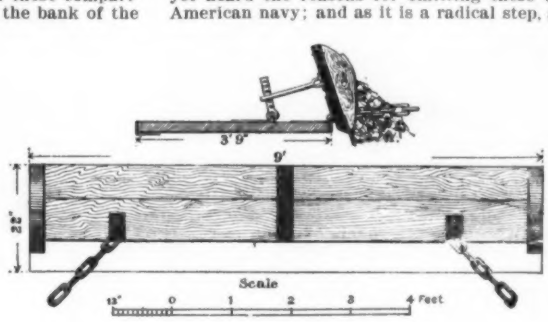
In the irrigation of grass land, clover, alfalfa, and similar forage plants it is not feasible to level the ground and build checks. Water must be applied by some form of flooding. It is conducted to the upper part of the field and there turned loose in such a way as to cover the surface with a thin layer. Much care is required to do this, far more than when checks or furrows have been made. To get the water to the right places it is usual to provide through the fields shallow depressions which serve to guide the water. From these it spreads out in thin sheets.

The irrigator takes advantage of all of the smaller ridges or inequalities, running the water out upon these and not allowing it to escape into the depressions until it has thoroughly wet the surface. Not all of the water will soak into the ground, and the amount in excess which collects in the depressions is again conducted along contours to the next lower series of ridges. The streams of water are distributed, gradually vanishing into the grass land or cultivated field. A portion of the stream reappears in the low places; these streams, when they attain considerable size, are gradually conducted out and used in lower portions of the field.

(To be continued.)



APPLICATION OF WATER BY BLOCK SYSTEM.



BUCK SCRAPER.

Correspondence.

TORPEDO TUBES IN THE JANE NAVAL WAR GAME.

To the Editor of the SCIENTIFIC AMERICAN:

I noted with great interest the fact that in the Naval War Game, which you described in your last issue, the American fleet was beaten by the German on account of the lack of underwater torpedo tubes. I have never yet heard the reasons for omitting these tubes in the American navy; and as it is a radical step, and opposed to foreign practice, I should like very much to hear the pros and cons discussed in the SCIENTIFIC AMERICAN.

Certainly the two tubes which were to have been fitted in the "Georgia" class did not occupy space that was especially valuable for any other purpose, and the only apparent gain is in a slight reduction in cost. It would appear, therefore, as if these weapons were absolutely valueless in the opinion of our naval authorities.

There was a bitter attack on this omission of torpedoes in our large cruisers and battleships at the last meeting of the Society of Naval Architects, and Admiral Bowles in reply simply states that it was the wish of the "General Board," and that he was complying with this.

It would certainly seem as though in battle, as a last resort, when a ship was badly crippled, they might be of some use, especially in a fast cruiser. G. B. M.

Bath, Me., December 26, 1902.

[Above-water torpedo tubes were omitted from our later ships because of the great risk of the torpedoes being struck and detonated by the hail of rapid-fire shells from the many small pieces of the enemy. The below-water tube, however, is entirely free from this risk, and our correspondent is quite correct in his belief that in the later stages of a hard-fought fight the under-water tube might be "of some use." It might indeed turn defeat into victory.—ED.]

THE WAR GAME WAR BETWEEN THE UNITED STATES AND GERMANY.—IV.*

By FRED T. JANE.

ACTION OFF THE SOUTH AMERICAN COAST—THE "IOWA" IN ACTION.

[No diagrams are issued with this installment, as the battle described does not require them.]

AT the outbreak of the war the American force in South American waters consisted of the battleship "Iowa" and the old cruiser "Atlanta." These were assumed to be lying at Montevideo, and they were kept here a few days pending certain slight repairs that the "Atlanta" was assumed to require. It may here be observed that such matters came about by a scale of chances, the idea being that this particular

* Prepared especially for the SCIENTIFIC AMERICAN by the well-known naval expert and inventor of the naval war game; with exclusive rights in the United States and Great Britain. This series was begun in the SCIENTIFIC AMERICAN SUPPLEMENT of December 20, 1902.

element in the scale of readiness or the reverse needed allowing for. It is certainly an incident that largely affects a real war, as witness the delays to Admiral Cervera's squadron in the late conflict with Spain. This particular instance is, of course, an extreme one; but in some form or other the same kind of thing marks every war.

The "Atlanta," therefore, was delayed for five days at Montevideo, and the "Iowa" stood by her there. The ships were then further delayed by order for three more days pending information as to the movements of the first German fleet that went to Ceuta. So soon as it was definitely ascertained that this division was actually bound for the Far East via Suez, the "Iowa" received orders to go round the Horn and reinforce the American fleet in the Philippines.

Meanwhile the Germans in the South Atlantic had not been inactive. The second-class cruisers "Vineta" and "Freya" had been lying at Rio de Janeiro at the outbreak of hostilities. They steamed thence direct to Montevideo, but any intentions to remain off that port were negatived by the coal problem. They bore off, therefore, and after some cruising fell in with a German steamer. This vessel they took with them to Neuva Bay on the Patagonian coast, where they transshipped all her coal into their own bunkers, after which the "Freya" went to Bahia Blanca. At this place she in due time received news of the sailing southward of the "Iowa" and "Atlanta." She then rejoined her consort, the "Vineta," and the two put to sea looking for the "Iowa."

Here they succeeded in finding, and, having found, remained observing on the horizon, intending to wait till night and then try and rush the battleship in a torpedo action—a by no means unsound plan. The only drawback to it was that the intention was fairly obvious. Not being minded to run risks of this sort, the captain of the "Iowa" altered course when night set in, steaming very slowly back on his tracks and then stopping altogether till dawn. The enemy, who had laid course to intercept the American division about two in the morning, failed, therefore, to sight it at all. They picked it up, however, a little after dawn, and the whole of the next day was spent in some futile maneuvers along the fortieth parallel. The American ships tried to entice the Germans to action, first by steaming at them; then, when this proved useless, the "Atlanta" was dropped, in a ruse to draw the German ships to try and cut her off. They were too wary thus to be brought to action. After this the American operations were less obvious but more cunning. The "chase" of the 18-knot cruisers by ships unable to do 15 knots was renewed, with the double object of pushing the Germans further out into the Atlantic and of making them burn as much coal as possible. In this, success was achieved; for the Germans, having their own reasons for not getting too far from their temporary base, were driven to steam at full speed so as to get round and place themselves inshore of the "Iowa" and "Atlanta." Toward night the "Iowa" simulated a breakdown, lying by till the darkness fell. But the Germans were not to be drawn.

With the night the "Iowa" made use of the time-honored subterfuge of steaming away quietly, leaving a boat with a dim light. She went straight on her proper course, and during the night saw nothing of the Germans, nor did she see them in the morning. Altering their tactics, they had steamed straight away south at full speed. At daylight they were many miles ahead. In the course of the day they fell in with and captured an American tramp steamer, and being in desperate need of coal they took her into Camarones Bay and proceeded to take her coal. They had just finished doing so when the American squadron, by the purest chance, came to the head of the bay; and an action was inevitable.

The "Iowa" is a second-class battleship, obsolete as battleships now go, and alone cannot be considered more than a bare match for the two cruisers. The "Atlanta" is a vessel of small account save in so far as her relatively heavy armament is concerned; her protection being very nearly a minus quantity. Unarmored though the German "Vineta" type is, the guns are armor protected, and tolerably numerous. The two ships, therefore, accepted the inevitable with good grace, and with some hopes of a successful issue.

In such a battle the tactics of the cruisers are necessarily simplicity itself. To rush in and torpedo is the obvious duty of cruisers engaging a heavier and slower force. The "Freya" and "Vineta" therefore went full speed for the American squadron, and this wisely did all in its power to keep away. The "Iowa" steamed off, keeping the "Atlanta" under cover. This was necessary; to bring the "Atlanta" into action merely meant losing her under the heavy rapid-fire that the Germans could bring. But the loss of the guns that the "Atlanta" could have brought into action was a heavy handicap to the American division, and in consequence the "Iowa's" fire was inferior from the first, the Germans getting in at least three to her one.

Quite early in the action, and before a single hit had been secured, the after big gun turret of the "Iowa" was jammed. She had only her 8-inch left to fight with, and soon one of the 8-inch turrets shared the fate of the big turret aft. Meanwhile the Germans, apparently little hurt, had got within three thousand yards.

Matters were thus when the "Iowa," driven to it by the necessities of the case, veered round so as to bring her forward guns into action. This movement, information of the intention not having been conveyed to her consort, exposed the "Atlanta" to the German fire, and she was almost immediately wrecked by the broadsides of the "Vineta." Her return fire was ineffective save for one shell that hit fair and square on the "Freya's" conning tower—she having selected this ship. At the same time the "Iowa's" big guns were fired, and one of them took the "Freya" on the waterline amidships, getting into the engine-room.

This settled the "Freya." A lull in the battle followed, for the disabled "Atlanta" drifted across the "Iowa," masking her fire, and the "Freya" was in the way of the "Vineta." This vessel took the opportunity to sheer off.

The "Iowa," at last getting clear of the "Atlanta," started in pursuit, not heading directly for the German, but for a point of the bay equidistant from either.

In this stage of the action it was the American vessel that suffered most from gunfire. She could, save for the 4-inch guns, bring only two 12-inch and two 8-inch to bear against one rapid-fire 8-inch and four 6-inch from the "Vineta," added to such of her broadside pieces as the disabled "Freya" was still using. In a comparatively short time only one of the 8-inch bearing in the "Iowa" remained in action, and the "Vineta," though badly damaged, was unsubdued. Still, her speed had sunk, and the "Iowa" got near enough to aim at her stern, where a lucky 8-inch shell found the steering gear at an opportune moment. Disabled, the "Vineta" went ashore. She continued firing, however, but the "Iowa," having at last got one of her after big guns into trim, came round and gave a settling shot from that piece.

Meanwhile the "Atlanta," acting without orders, had made a stealthy attempt to close with the disabled "Freya." In this she was eminently unsuccessful, for the "Freya" abstained from firing till the "Atlanta" was near, then fired a torpedo with fatal effect. Subsequently she struck to the "Iowa."

A summary of the guns engaged in this interesting little action is as follows:

Inches. ..	12	8 R.F.	8 B.L.	6 R.F.	4	3.4
U. S. A...	4	2 (old)	8	6 (old)	6	—
German ..	—	4	—	16	—	20

But of the United States guns the two old 8-inch and six 6-inch were not in the action for any length of time. Most of the battle was a case of two 12-inch, four 8-inch B.L., and two 4-inch against two 8-inch R.F., eight 6-inch and twelve 3.4-inch—a very equal match. And it may be observed that the whole thing was rather of the nature of a toss-up, the lucky shot being the predominating factor.

The damages sustained by the "Iowa" were heavy. Her upper works were totally wrecked, and her entire bow in the same condition. As for the Germans, the "Vineta" was a complete wreck, and destroyed, while the "Freya," besides the loss of all steaming capacity, was tremendously knocked about. The "Iowa" got her as far as Bahia Blanca and there left her, remaining herself pending news as to whether it was possible for her to return home without the certainty of being captured.

An interesting point was raised over the fact that this action was fought in neutral waters. Should it have been allowed to take place? was the question formulated. The decision was that probably it would have done so in actual war. Argentine control over Patagonian waters is of a nominal nature in many ways, and presuming that both sides meant fighting the assumption was made that the Argentine authorities would shut their eyes. It was argued that the American vessels would certainly not forego their only chance against the faster Germans for the sake of any diplomatic fictions; that the Americans would certainly have attacked on such a golden chance. To attack was necessary, whether as an act of self-preservation or for the protection of any American commerce in the South Atlantic.

OTHER MOVEMENTS.

A lull and a dearth of incident followed this action. Everything centered on the Far East and the possible danger to the American western seaboard. Eastward steamed the American Mediterranean division, astern of it a superior German fleet. The future was obvious; but in view of the second German fleet at Kiel, the American home squadron in the North Atlantic was debarred from going round the Horn to the center of trouble at the Philippines.

A month after the outbreak of war the American European division was at Manila. Here it coaled and revictualed, then, scouts bringing in the news of the approach of the great German fleet bound for Kiau-Chow, the combined American squadrons went out for a battle against a larger fleet worn with a long voyage. The issue at stake was the base at the Philippines, and the whole of the western American freeboard. Far away, at last bound for the same waters, was the American home fleet. An Isthmian canal would have enabled it to reinforce the Far Eastern squadrons in ample time; round by the Horn this was not possible. The fleet might have done so had it been able to start directly the German move was known, but the umpires would not allow it.

The decision—and it probably expresses the thing that would actually happen in such a case—was as follows: Bearing in mind the fact that the Germans have at Kiel a second fleet consisting of "Brandenburgs" and some of the "Wittelsbach" type, and that this fleet—did the United States North Atlantic squadron withdraw—would be in a position to cross the Atlantic and destroy the American eastern coast, it is considered that American public opinion would prevent the sending of the home fleet to the Philippines, at any rate till such time as a force of monitors could be collected and put to patrol the coasts of the eastern seaboard. And it is considered that, one way and another, this fleet would not be able to depart further south than West Indian latitudes till about three weeks after the arrival of the first German fleet at Ceuta. This decision was protested against, but the umpires held their ground, and further pointed out that the mere decision to send the North American fleet to the Philippines could not be put into effect within a week or so, and that this delay, apart from any other, would prevent this fleet from arriving on the scene in time to participate in the coming Armageddon off the Philippines.

MODERN QUICK-ACTING, CONTINUOUS AIR BRAKES FOR RAILWAY TRAINS.

THE application of the brakes of a train is not instantaneous. It does not occur simultaneously upon all the cars, but begins upon the tender and baggage car and gradually reaches the end of the train. The braking of the last car is effected with a retardation, with respect to that of the first, dependent upon the rapidity of propagation of the brake-applying medium and also upon the length of the train. With automatic compressed air brakes, what produces the application of the latter is the depression that the engineer brings about in the general conduit or main brake pipe by means of the operating cock. If such depression is established at the rate of 165 feet a second, and the length of the train is four times that number of feet, the brakes of the last car will not be applied till 4 seconds after those of the first. With a train speed of 43 miles an hour, say nearly 65 feet a second, the space traversed during the time that intervenes from the moment the brakes are applied on the tender to that at which they are applied on the rear car, will, under such circumstances, reach nearly 260 feet. The lack of simultaneous action of the brakes will cause the rear car to ram the forward ones, thus bringing about violent reactions throughout the entire train, and perhaps breaking some of the couplings. It is to prevent such breakages, which might prove a source of important delays and serious accidents, that the air brake companies have devised various rapid action arrangements.

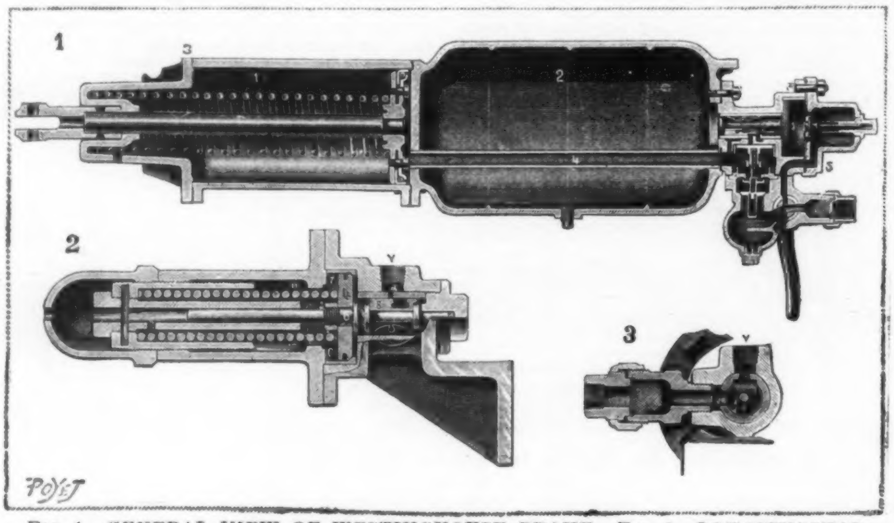


FIG. 1.—GENERAL VIEW OF WESTINGHOUSE BRAKE. FIG. 2.—LONGITUDINAL SECTION OF VALVE. FIG. 3.—TRANSVERSE SECTION THROUGH THE ESCAPEMENT ORIFICE AND THE VALVE.

The Westinghouse Company has occupied itself with the question of the braking of long trains, in France, since the year 1886. The first experiments were made with trains for mobilizing troops, which are made up, normally, of 50 cars. In the ordinary Westinghouse brake, the air that the engineer allows to escape from the main conduit, in order to cause the operation of the triple valves, must pass entirely through the cock of the engine, and this retards the braking of the cars if the train is of a certain length. In order to obtain a more rapid escape of such air, one of the peculiarities of arrangement of the ordinary triple valve has been made use of in such a way that the valve opens wide when the train is braked to a standstill, while with a moderate application of the brakes it opens only half way. The movement of the valve when completely opened has been utilized for opening a direct communication (see Fig. 1) between the general conduit and the brake cylinder, 1, by means of the tube, 4, that traverses the auxiliary reservoir, 2. The effect of such communication is immediately to lower the pressure in the conduit near the triple valve, 5, of the following car, which valve then also opens wide and causes, in its turn, a communication of the conduit with the brake cylinder. Such action is therefore propagated very rapidly throughout the entire length of the train, each brake cylinder receiving air from the conduit of the corresponding car.

The quick-acting Westinghouse brake has permitted of reducing the space and time required for stopping long mobilization trains by 50 per cent. In face of such a result, the Railway Company of the North has applied it to its passenger trains, and has thus been able to reduce the time necessary for making stops by

20 per cent. The Orleans Company, on its part, is changing the Wenger brake, which it adopted in 1883, for the quick-acting Westinghouse one, and, in addition, is applying to its high speed rolling stock a high pressure arrangement that still further increases the efficiency of the quick-acting brake by 20 per cent.

In order to stop a train in the minimum time, it is necessary that the pressure exerted upon the brake shoes shall always be as great as possible, without its being sufficiently strong at any moment, however, for the chocking of the wheels to take place, since the retarding action of the brakes would be diminished thereby. On the other hand, the coefficient of friction of the shoes increases when the running speed diminishes, as has been demonstrated by the experiments of Douglass Galton in England. Consequently, the pressure upon the brake-shoes should always be proportionate to the speed and should therefore diminish when the speed itself diminishes. But in the Westinghouse automatic brake it is impossible to produce a progressive pressure upon the pistons, and in order to prevent the wheels chocking at low speeds, it is therefore necessary to moderate the action of the brakes at the beginning of their application, so that the friction, near the end of it, may not exceed the adherence of the wheels to the rails. It will be seen, then, that at the beginning of the braking the entire pressure that might be employed in applying the brake shoes is not utilized, and so the train cannot be stopped in the minimum of time. The Westinghouse Company is nevertheless of the opinion that the quick-acting automatic brake is energetic enough for the majority of express trains; but that, for exceptionally fast trains which have to pass stations without slowing down, a more powerful brake is necessary, or at least desirable; and so it has raised the pressure in the auxiliary reservoirs from 70 to 97 pounds, in order to have this latter pressure in the cylinders at the beginning of the braking in cases of emergency. In order that the wheels may not afterward become chocked as soon as the train loses speed perceptibly, a reduction valve connected with the brake-cylinder allows air to escape from the latter so as to reduce the pressure therein progressively to 52 pounds. Fig. 2 shows a longitudinal section of this valve, and Fig. 3 a transverse section through the escapement orifice, *a*, and the slide valve 8. It will be seen that the brake-cylinder is in constant communication, through a conduit, with the piston 4, which is held in the position shown in the figure by an opposing spring, 11, when the pressure of the air in the cylinder, and consequently upon the piston, is equal to or less than 52 pounds to the square inch. But when the pressure becomes greater than this figure, the piston 4 moves downward at 7 and puts the interior of the valve 8, with which it is operatively connected, in communication with the atmosphere through the small orifice *a*. The air therefore escapes from the cylinder to the brake until the pressure in the latter has been reduced to 52 pounds. At this moment the spring 11 causes the ascent of the piston 4 and slide valve 8, and, consequently, the closing of the orifice *a*. The pressure in the cylinder then remains stationary until the end of the braking.

For a moderate braking, the pressure in the brake-cylinder does not exceed 52 pounds to the square inch, as in the ordinary brake, and the reduction valve does not enter into action.

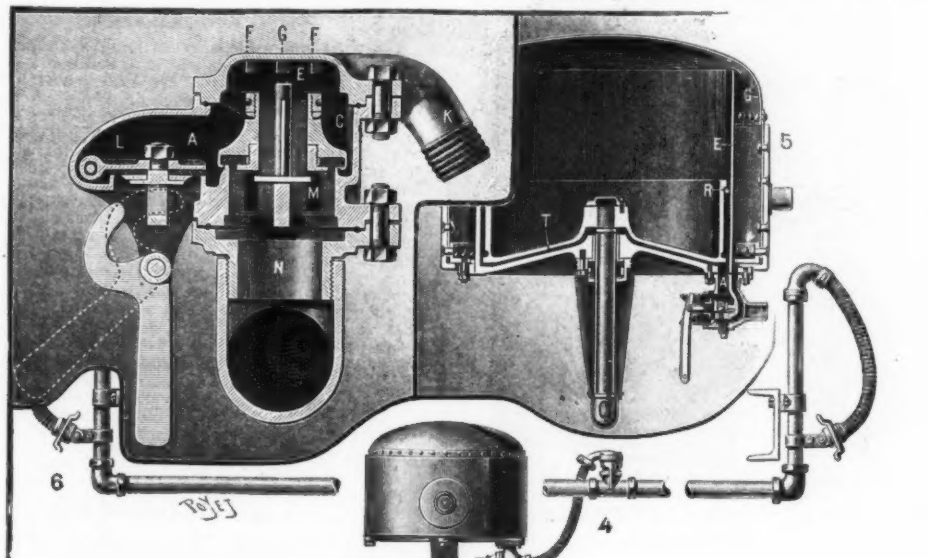
The Westinghouse Company has also devised a very simple arrangement which converts the ordinary automatic brake into a quick-acting one.

The ordinary automatic brake known as the "Clayton" we have already described, and we shall therefore merely recall the principle of its operation.

Brake-cylinders (Figs. 4 and 5) placed under the cars are connected by means of a main conduit with an ejector arranged upon the locomotive, and a certain degree of vacuum is kept up in the conduit and cylinders by means of this injector. Application of the brakes is produced by the entrance of air into the conduit. A ball valve then permits this air to enter the lower part of the cylinders, beneath the pistons, which, in rising, apply the shoes to the wheels. Thus, in this system, the external air, which, upon entering the cylinders causes the application of the brakes, enters the conduit that supplies these cylinders only through the injector placed upon the locomotive. The conduit is therefore filled only gradually, and the result is that, with the different cars of the train, there is a retardation in the braking which is proportional to their distance from the locomotive.

In order to increase the rapidity with which the air enters the main conduit, there is mounted upon the latter under each car (Figs. 4 and 6), a valve connected with the brake-cylinder. When the brakes are applied suddenly with full force and a large amount of air is let into the conduit, this valve puts the lower chamber of each cylinder in direct communication with the atmosphere. The external air thus enters each cylinder by a direct passage, and the braking is considerably accelerated.

The operation of the rapid valve is as follows: The air introduced into the general conduit through the abrupt opening of the ejector produces undulations that raise the small valve *M* (Fig. 6) and press it against the valve *C*. The two valves thus form but one, and, in rising together, put the chamber *N*, in which there is a vacuum, in communication with the small chamber *A*, in which an atmospheric pressure existed. A vacuum is thus established in the latter, and the clack-valve *L* is raised under the action of the external air upon its outer face. This air enters, then, at *A*, and goes thence to *N*, thus pressing the clack-valves *M* and *C* respectively against the stops *G* and *F*. But the valve *M* first comes into contact with *G* and thus separates itself from the valve *C*, so that the external air then passes through the channel formed in the latter into the chamber *E* and conduit *K*, finally entering the lower chamber of the brake-cylinder, where it acts forcibly upon the piston so as to produce an energetic application of the brake-shoe. Besides, the air entering the conduit through the clack-valve *L* reinforces the initial undulations produced therein, and these undulations are thus communicated more rapidly to the valve of the following car. When the brakes are applied but slightly the undulations produced in the general conduit are not sufficiently strong to lift the valve *M*. The air, passing through the channel of the valve *C*, then enters the chamber *E*, and thence passes into the lower part of the cylinder; consequently, the quick-acting valve does not enter into play.



CLAYTON BRAKE.—FIGS. 4 AND 5.—BRAKE CYLINDERS; GENERAL VIEW AND INTERNAL DETAILS. FIG. 6.—QUICK-ACTING VALVE.

This system of quick-acting brakes has just been adopted on the passenger trains of the various great lines of the Austrian railways, after a trial of the different systems of continuous brakes made upon the Arlberg line, which has a mean inclination of about 1.18 inch to the foot. The tests, made upon trains of 20, 25, and 30 cars, consisted in maintaining a constant speed of 21 miles an hour upon the above mentioned gradients and then, upon order, stopping quickly, the brakes having been moderately applied beforehand. The deviations over and above such speed were very slight in the trains provided with a vacuum brake. This brake, besides, was found to be very energetic and very simple in operation.

Out of an average of eight stops the results were as follows:

Speed of the train at the moment of application of the brakes, 21.73 miles per hour; space traversed in making the stop, 150.92 feet; time required, 7.5 seconds.

In some experiments made upon a train at a standstill it was found that the brake-shoes began to press on the wheels of the thirtieth car 1.65 second after the brake-valve was opened, and the full pressure was on at the end of 3.34 seconds.—Translated for the SCIENTIFIC AMERICAN SUPPLEMENT from La Nature.

THE PAN-AMERICAN UNION AND THE BUREAU OF THE AMERICAN REPUBLICS.

THE International Union of American Republics, popularly known as the Pan-American Union, has existed since 1890. Its organization was effected by the International Conference of 1889-90 held in Washington, and an institution, known as the Commercial Bureau of the American Republics, was established as the organ of the Union. It was located in Washington, and its support provided for by contributions from the several republics in proportion to the population of each. Manifestly the reason for the establishment of the Union was the fostering of the friendly relations between all the republics, the dissemination of a more general knowledge of the social and economic conditions obtaining in the various portions of this hemisphere and for improving business intercourse and extending trade relations. To bring all this about, a more perfect understanding of the commercial methods, laws, local usages, trade regulations and requirements, and a more extended knowledge of the products and natural resources are necessary. The work of the Bureau of the American Republics has been carried on in the endeavor to be of assistance along the lines indicated, although the purpose of the Bureau was simply defined by the Conference to be the publication of information relating to customs tariffs, port regulations, trade statistics and data of similar character.

In 1893 the publication of a Monthly Bulletin was inaugurated. It is a magazine printed in the English, Spanish, Portuguese and French languages, containing information regarding the industries, trade, manufactures and general resources of the several republics. Its edition is now 11,000 copies, 9,000 of which are distributed throughout Latin America. An extra edition of 5,000 copies has been printed since July, 1900, by order of Congress, for distribution in the United States on orders of Senators and Representatives. In addition to this regular monthly publication, handbooks of the several countries have been issued from time to time, containing general and specific information drawn from official and other reliable sources. The demand for these publications has been great; libraries, institutions of learning and the general public have been the recipients. It is particularly noticeable that the public schools of the United States, whose special attention has been directed of late to the study of Spanish-American affairs, are among the most frequent applicants for the Bureau's publications. In preparing the Bulletin, recourse is had to all useful periodical publications of Europe and America. Over 1,700 periodicals, including daily newspapers, are received, and all important information contained in them is translated, compiled and published. Furthermore, a number of prominent persons in the several republics, entitled Honorary Corresponding Members of the International Union, co-operate in its work by the frequent transmission to the Bureau of important information.

An important work recently undertaken by the Bureau is the preparation of maps of the several republics on a uniform scale, and giving their general geographical, as well as economic features, railway and telegraph lines, mines, etc. The sheets giving Mexico and Guatemala have already been published, and those of several other republics are in the printer's hands and will shortly be ready for the public. In accordance with the recommendation of the International Conference, the Bureau has also published a Code of Commercial Nomenclature of over 50,000 terms in English, Spanish, and Portuguese. This code has been adopted by the United States Treasury Department and the Republic of Paraguay as a standard for use in the custom houses.

The First International Conference provided that the Union should continue in force for ten years, and indicated the manner of its further continuance. It is now, therefore, in the second decade of its existence, and includes at present every republic in the western hemisphere.

It was early recognized that the lack of an agency to carry on the work initiated by the First International Conference was one of the chief reasons why it did not accomplish as much as its projectors had anticipated. It was, therefore, determined by the Second International Conference, held in Mexico in 1901-02, to reorganize the Bureau, or rather to broaden and expand its existing organization. Its name was changed to that of International Bureau of the American Republics, and the management made more in harmony with this appellation. The affairs of the International Bureau are now conducted under the supervision of a Governing Board composed of the Secretary of State of the United States, who is chairman, and the Diplomatic Representatives in Washington of all the other governments represented in the Bureau, in other words of all the American republics, now numbering twenty.

The committee for this reorganization stated in its report to the conference at Mexico:

"The Committee on the Reorganization of the Bureau of American Republics believe that the establishment of said bureau was one of the most important acts of the First Conference of the American Republics. They recognize that the bureau has been a useful factor in bringing the American republics into closer relations, and that credit is due to those who have been concerned in its management. Each of the republics has obtained, through its agency, knowledge of the resources and productions and of the commercial needs of the others, resulting in the extension of commerce and in benefit to the countries interested in the bureau. It is the belief of the committee that the usefulness of the Bureau may be increased by broadening the basis of its organization, by enlarging its powers, and by imposing upon it additional duties."

Under the plan as adopted the International Bureau now corresponds through the diplomatic representatives with the executive departments of the several governments. It furnishes information to any of the republics requesting it. Each of the republics sends to it two copies of each of its official publications and supplies such information as may, from time to time, be requested by the Director. All of the publications of the International Bureau are public documents, and as such are carried free in the mails of all the republics. The Director of the Bureau attends all meetings of the Governing Board and of all its committees, and will attend as well the session of all future International Conferences. The Bureau is the custodian of the archives of the International American Conferences, and is charged with the performance of any special executive duties imposed upon it by the Conferences. These additional duties specifically imposed by the Conference in Mexico were: The carrying out of the provisions of the resolution adopted looking to the collection, compilation and dissemination of more complete statistical data and informa-

tion regarding the resources of the several republics, the fixing of the date for and the performance of the general executive work of the Commission to investigate the crisis in the coffee industry, similar work for the Sanitary and Customs Congresses, and the keeping of the accounts of the American International Archæological Commission when organized.

In addition to these duties specifically prescribed by the Conference, the Committee on the Reorganization of the International Bureau of the American Republics, in the report accompanying the plan of reorganization, recommended to the Governing Board of the Bureau that it should collect, compile, and keep on file, and should publish, to such an extent as might be practicable, information regarding commercial laws; the banks of the American republics, their stock and deposits; the patent laws of the several republics with reference to patent litigation; complete monthly reports of exports and imports of the several republics; the arrivals and departures of vessels from ports of the American republics, with their tonnage; the length, stated in miles and kilometers, of railway, street railway, telegraph and telephone lines in the several republics, with complete data as to the new lines projected or being built; information regarding new enterprises of a private character, so far as can be obtained; information regarding new public works of all kinds; complete vital statistics of each of the republics and of its important cities, and such other information as the Director, with the approval of the Governing Board, might determine.

The Governing Board of the International Bureau of the American Republics has already taken up the new duties imposed upon it by the action of the Conference. The Coffee Commission held its sessions in New York from October 1 to October 31, and a report of its conclusions have already been sent to Congress. The sanitary Convention was held in Washington from December 2 to 5, inclusive, and the Customs Congress is called to meet in New York on January 15, 1903.

The necessity of forming a good library, especially of official publications of the American States, was realized by the Conference which founded the Bureau; it originated with the idea of creating a monument to the work of the Conference. This idea was further emphasized by the Second Conference, with the result that the following resolution was passed:

"In order to commemorate the First and Second International American Conferences of Washington and Mexico, a Latin-American Library shall be established under the authority of the Governing Board of the International Union of the American Republics, as a part of the bureau of the same, which library shall be designated by the name of 'Columbus Library.'"

The Committee expressed the opinion that in view of the large and important libraries already existing in Washington, in which all publications relating to the United States were to be found, that the Columbus Memorial Library should be devoted particularly to the collection of literature concerning the other states of the Western Hemisphere. With the official publications as a nucleus, a library of about 10,000 volumes and pamphlets has already been built up by gifts, purchases and exchanges, and the library possesses also a valuable collection of maps and photographs. It receives all the official publications and most of the periodicals and scientific magazines of Latin America, and the peculiar value of its collection is being generally recognized by all in Washington who are devoting their attention to American questions.

The above briefly outlines the origin of the Bureau, its past work and present usefulness, and the elasticity of its organization, which has permitted it, without any deviation from the original idea which brought it into existence, to become from an office devoted to purely commercial affairs, an executive bureau charged by the several states with the preparation and carrying out of various other functions. The scope of its work does not yet seem to have been definitely limited, and it is believed that in the future it may be found useful in many other ways.

GETTING DRUNK ON ALCOHOLIC AIR.

There can be little doubt that the air of distilleries, wine and spirit vaults, and drinking saloons must at times contain appreciable amounts of alcohol, and the question has arisen as to whether air containing traces of alcohol would be prejudicial to health. Our attention has been drawn by a correspondent to one instance in which definite steps were taken to ascertain whether the air of an office in a wine and spirit warehouse contained alcohol vapor.

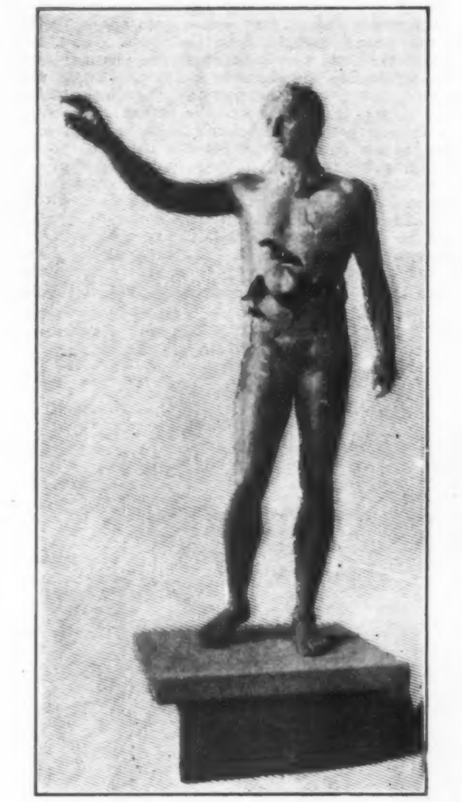
It is well known, of course, that where wines and spirits are stored there is invariably a sort of alcoholic smell, and it has been stated that a walk through the cellars at the London Docks, where large quantities of spirits are stored, has at first a peculiarly stimulating effect, followed by depression, headache and nausea. In the same way the stranger on his first visit to the great sherry bodegas in the south of Spain experiences at first a decided sense of exhilaration with quickening of the pulse, followed by a narcotic effect, a feeling of languor, and headache. In the great brandy stores of Cognac, again, to some people the air is sickening.

It might be naturally expected that the more volatile constituents of wines and spirits would be the first to evaporate into the air, and possibly the volatile ethers would thus prevail. We have heard it said that the effect of inhaling the air of the sherry vaults is more marked than when other spirituous liquids are kept in the store. It is, of course, well known that sherry is a highly ethereal wine. There would, therefore, appear to be some ground for concluding that when air is impregnated with the volatile vapors of spirits or wines it has a marked effect upon health. Whether this effect would be pronounced or not upon those inhaling the air day by day does not appear to have been ascertained with certainty. It is probable, however, that at any rate some slight deterioration of health would take place.

It is pretty commonly asserted that publicans and barmaids experience ill-effects from the constant inhalation of an alcohol-contaminated air, but their environment, of course, provides a combination of unhealthy factors. According to an examination made of the air of a distillery it would appear that no less than an ounce of proof spirit or half an ounce of absolute alcohol may be present in five cubic feet of air. It is obvious from this result, we think, that a very appreciable amount of alcohol would be inhaled during a stay, say, of eight hours in such air. And since the alcohol by the medium of the lungs would rapidly gain access to the circulation, the conclusion must be in favor of the view that such air would in the long run be detrimental to health, and therefore that in such a case special arrangements for particularly efficient ventilation are indicated.—The Lancet.

THE RECONSTRUCTED STATUE OF PERSEUS.

M. André, a French artist, has for some time been at work on a restoration of the bronze statue recovered from the sea bottom off the little island of Antikythera (Greece) last year. His work was carried on in a studio, specially fitted up for the purpose, in the National Museum of Athens. The restoration is now completed, and the view we publish of it shows the antique master-



ANDRÉ'S RECONSTRUCTION OF THE STATUE OF PERSEUS.

piece in something of its original glory. M. André is of the opinion that the figure represents Perseus displaying the Gorgon's head.

ZIMBABWE RUINS.

The secret of the ancient ruins of Zimbabwe, with its acropolis, temple, and forts, has not yet been laid bare. It is still uncertain to whom we owe these mysterious structures and at what date they were erected. A very good case has been made out for identifying Zimbabwe as the Havilah of the Old Testament, and for supposing that Phœnicians or descendants of Phœnicians had a hand in its erection. One thing is certain: that the buildings are not the work of any of the present natives of South Africa, although they may have been used over and over again by local tribes. Native implements found in the ruins prove this. Perhaps the greatest puzzle is the *raison d'etre* of the situation of the ruins. The acropolis is situated on a kopje 250 feet high in a plain surrounded by hills, and affording an extensive view along several valleys. The temple is situated in this plain, and down one of the valleys there is a long chain of forts striking eastward as if making toward the coast. The curious part is that there are in the immediate vicinity none of the ancient gold-workings which abound all over South Rhodesia, and there still exists the unsolved problem of the situation of Zimbabwe.

Perhaps in the near future the truth may be disclosed. The government of South Rhodesia, says the Scotsman, have taken a very important step for the preservation of the ancient ruins. They have appointed Mr. R. N. Hall, who is joint-author with Mr. Neal of "The Ancient Ruins of Rhodesia," as temporary curator of Zimbabwe. It is to be his work to clear away all rubbish and vegetation that tends to conceal or to destroy the buildings. Mr. Hall arrived at his station on May 23 and already a great amount of work has been done. The walls inclosing passages which wind round and up the kopje to the inclosures on the top have been laid bare, and passages have been disclosed which were not previously thought of. Two of these passages, 20 and 30 feet long respectively, and between walls 8 feet high, were so concealed with rubbish that the visitors' path crossed right over them. Two large ancient entrances have also been discovered. They had been used by the native Makalangas for graves. Other architectural discoveries are a wall with dentelle pattern, a cement-lined inclosure and three wedge-shaped buttresses. The buttresses are of peculiar interest, being the first discovered in Rhodesia. Naturally, in the rubbish cleared away many "finds" have been made. These include the characteristic soapstone birds, beams, and bowls. The birds are decorated in the usual fashion, and the beams and bowls show chevron and cord patterns and sometimes figures of animals. Pottery and iron tools have been discovered, but whether they are of very ancient date it is impossible to say. At any rate, they are not such as used by natives of the present day. Perhaps the most valuable discovery is a gold bangle of wirework, weighing 3½ ounces, and a beaten gold-cap, or ferrule.

Although the acropolis, with its winding walls of granite blocks, its monoliths and chambers, is the most imposing ruin, the most interesting ruin and the one in which more "finds" are likely to be made is the temple in the plain below. A few months ago the interior of the elliptical temple was one impenetrable jungle of trees, bushes, tall grass and creepers. The monkey-rope tree and the wild vine have committed great depredations, and the last remnant of the herring-bone pattern on the walls was fast disappearing. Mr. Hall's arrival was very timely. With the help of fifteen natives he has cleared away all the undergrowth and stumps, and now for the first time an uninterrupted view of the whole structure can be obtained. The most striking object is the large conical tower, about 15 feet high, which is suggestive of the old Phallic worship. This cone has suffered somewhat from the growth of trees, and is now slightly tilted. The architectural discoveries made in the temple are: four ancient drains, a double-curved rounded entrance, three sets of stone steps, and several yards of ancient cement flooring. The cement flooring is not original with the building. There has also been made clear a large portion of architecture which is of later date than the original building, but built on the top of an original wall. The "finds" in the temple are similar to those on the acropolis. Altogether twenty-five monoliths have been found. Among the soapstone ornaments is a section of an ancient soapstone bowl believed to be the missing portion of a large bowl lent by Mr. Rhodes to the Cape Town Museum. A collection of curious stones, foreign to the district and of odd natural shapes, was also found.

The work undertaken by Mr. Hall is purely that of clearing away the rubbish and making known the nature of the structures. No excavations are being made, so there is still plenty of scope for discovery. It is impossible to imagine that the government mean to retain Mr. Hall only temporarily. The excellent work he has done insures his being intrusted with further research. There are so many old ruins in South Rhodesia that it will take years to investigate the whole of them. Mr. Hall has not been unmindful of visitors, and direction posts have been erected everywhere either to direct people to particular ruins or to indicate the particular nature of the chambers or inclosures. Zimbabwe is three hours' journey in a Cape cart from Victoria, in the south of South Rhodesia. Victoria is reached by coach now from Gwelo, which in a very short time will be connected with Bulawayo by rail. Doubtless, tourists in making the grand tour of South Africa through Kimberley and Bulawayo to the Victoria Falls will take the opportunity on their return journey to make a deviation to the unique ruins of Zimbabwe. It is to be noted that Victoria and Victoria Falls are not to be confused. They are several hundred miles apart.—The Architect.

AN OLD STEAMSHIP LINE.

The steamboat line between Bangor and Boston is the oldest, in point of continuous service, in America, the first steamers having been put on in the year 1824, seventeen years after the first practical application of steam to the propulsion of vessels. A year earlier, in 1823, a queer little craft called the "Patent," ran between Boston and Portland, and her first arrival at the Maine port caused great excitement. She was built in 1821, at Medford, Mass., and seventeen hours was considered good time for her to make between Boston and Portland. The "Maine," the "Legislator," and the "Waterville" came along soon after the "Patent," making trips from Boston to various Maine ports, and in 1824 the "Connecticut," which was built in New York, in 1816, to run between that city and New Haven, came to Bangor. She was of about 400 tons, rigged with masts and yards, and had an engine of the Fulton pattern, with balance wheel and couplings by which the engine could be thrown out of connection with the paddles.

The "Chancellor Livingston," in which Commodore Vanderbilt had an interest, was the next steamer of any importance to be placed on the Boston and Bangor line. She was built in New York in 1816, and was considered to be the masterpiece of Fulton. She had three smokestacks, three masts, a bowsprit and jibboom, and carried a huge squaresail on the foremast, with fore-and-aft sails on the main. The "Livingston" lost money because she was too much of a boat for the amount of business on the line, and Commodore Vanderbilt soon disposed of his interest, the owners who held on to their shares being eventually ruined. The "Victory," the "McDonough," and the "Portland," were also among the early boats, but the "Bangor," built in New York, was the first new boat, as well as the fastest up to that time, that came to Maine. She was of about 400 tons, well fitted for her time, and did a profitable business, generally carrying about one hundred and twenty passengers on a trip, at the rate of $6 each, between Bangor and Boston.

The "Bangor" ran on the route until the fall of 1841, and in 1842 she was taken to the Mediterranean, where for some time she was engaged in carrying pilgrims from Alexandria on their way to Mecca. When she arrived over there, being painted white, not a Mussulman would step foot on her, white being their mourning color, so she was then painted black, and afterward did a flourishing business in the pilgrim trade. The "Bangor" was purchased by the Sultan of Turkey and added to his navy. Another steamer, the "Bangor," a propeller, made a few trips between Boston and Bangor, and was then purchased by the United States government and sent out to take part in the

attack on Vera Cruz, where she won lasting fame. She was the first iron steamer built in America.

From 1835 to 1845 numerous steamers ran on the line between Boston and Bangor, including the "Charter Oak," "Huntress," "Sandusky," "Express," "Portland," and "Admiral." The "Charter Oak" was a fine boat, originally intended for the New York and New Haven line, where her owners, Capt. Memnemon Sanford and a Mr. Cunningham, found the competition of Commodore Vanderbilt so sharp that they sent the boat east. Vanderbilt followed them to Maine, with the steamer "Telegraph," and for several years there was such brisk rivalry between the two lines that the fare between Bangor and Boston, which had been as high as $7, was reduced to $1.

In 1845 Capt. Sanford put the steamer "Penobscot" on the Boston and Bangor route, and that boat, on the night of June 17, 1845, made the first trip to Bangor by what is known as "the outside route," going across directly from Cape Ann to Monhegan Island, instead of following along the coast as had formerly been done. It was on this occasion, also, that time courses were first used, the method being then adopted by Capt. Sanford for his New York and Philadelphia line, and afterward coming into general use.

The fifteen years preceding the civil war was a harvest time for steamboats on the Penobscot. There was no railroad from the western part of the State to Bangor until 1857, and so the steamboats had all the business. Some famous boats ran between Boston and Bangor in those days, including the "Senator," built by Daniel Drew of New York; the "Daniel Webster," named for the statesman—a large and handsome steamer, afterward sold to run on the St. Lawrence and renamed the "Saguenay"; the "Governor," "T. F. Secor," "W. J. Pease," and "Kennebec." It was on the "Kennebec," in August, 1849, that cholera made its first appearance in Bangor.

In 1851 was formed the company which for many years operated what was known as Sanford's Independent Line. Its originator, Capt. Memnemon Sanford, died in New York in the following year, and the business was continued by other members of the Sanford family. During the war nearly all the Down East steamboats were chartered by the government for transport service, and some of them, including the "Memnemon Sanford," a fine new boat, never came back to Maine. The latter day history of the Boston and Bangor line began with the coming on the route, in 1863, of the steamer "Katahdin," which was joined in 1867 by the "Cambridge" and in 1882 by the "Penobscot." The "Katahdin" was, in many respects, the most remarkable sidewheel steamer ever produced in the United States, and her fame spread far and wide. She was as good a sea boat as most of the propeller steamers, fast in her day and followed by the most surprising good fortune. Other boats were wrecked in storms that she went through without the least trouble, and other boats would strike on rocks along the dangerous coast of Maine that the "Katahdin" always dodged. She never lost a passenger or any freight, and, in short, such was her "luck" that Down East people, especially sailor men, came to regard her as bearing a charmed existence. She continued to run between Boston and Bangor, with the exception of a few winters on Long Island Sound, until the summer of 1895, when, the new steamer "City of Bangor" having come on the route, the old "Kate," as she was familiarly called, was broken up for her metal.

The "Cambridge," which was the fastest and most elegantly finished steamer that ever came to Bangor, was lost on Old Man Ledge, on February 10, 1886, by a blunder of her pilot. She was a popular boat, but had more than her share of bad luck, having been ashore several times, and once, when she was brand new, narrowly escaped loss, with all hands.

In the summer of 1901 the Boston and Bangor Steamship Company, which, formed in 1875, had succeeded the Sanfords, sold the line to the Eastern Steamship Company, a corporation organized by Charles W. Morse, of New York, and which has also acquired the Kennebec, Portland, and International lines. The business on the Boston and Bangor division is now done by the new sidewheelers "City of Bangor" and "City of Rockland," fine and large boats of their type.

Steamboating Down East is a different thing now from what it was in the old days. It is related by old travelers that before the war, and even later, the bill of fare on the boats consisted chiefly of ham and eggs. There was nothing much to eat, but plenty to drink. Now there is a great variety to eat, and not so much drinking. The dinners on the Boston and Bangor boats are as good as those served in most hotels, and the general accommodations are first class. The steamers have bars, but the liquors are dispensed with discretion.—New York Tribune.

TRADE SUGGESTIONS FROM UNITED STATES CONSULS.

New Wagon Road in Honduras.—It is advisable for our exporters to Honduras to make use, as far as possible, of the new wagon road which is being built between San Lorenzo, on the Gulf of Fonseca (Pacific Ocean), and Tegucigalpa, the capital city.

Through the active co-operation of the President and the Minister of Public Works, road building has been the chief feature of public activity in Honduras during the past year. The fact that Honduras has had no safe or convenient high roads has been one of the reasons for the tardy development of many enterprises in the interior of the Republic. The difficulty of transportation has been productive of excessive freight rates, and has prevented a large number of merchants from sending goods here, because of the elaborate and unusual methods required in packing to prevent damage by water. This will be unnecessary, in a large measure, as soon as bridges have been thrown over treacherous streams and the means of conveyance changed from mules to the modern freight vehicle, with its facilities for insurance against damage by rain or flood.

This new high-road is finished over half way to the coast, and as most of the section yet to be constructed runs over fairly level ground, the completion of the entire route is a matter of only a few months. The grade does not exceed 6 per cent in any place, and for the greater length it varies between 2 per cent and 4 per cent, giving a gentle ascent or descent.

From Tegucigalpa to Sabana Grande—33.5 miles—the road is excellent. In many places it is 50 feet in width. It is on a foundation of lava, the surface of which is arched and covered with finely beaten rock. Side ditches are constructed along the way, and nearly all the bridges and culverts are built of stone; but no bridges have yet been built across the large and really dangerous rivers.

From Sabana Grande to La Venta—10.5 miles—the road has been begun and can be traversed on mule back. One-fourth of the work, to make it serviceable for wagons, has probably been done. This section, over the old road, was the most difficult part of the line between Tegucigalpa and the sea.

From La Venta to Pespire—21 miles—there is a steep ascent, but by the new road, which will be much longer than the present one, the average grades will be maintained. From Pespire to San Lorenzo, on the head waters of the Gulf of Fonseca, the route is mainly level, and it is possible at present to drive any sort of vehicle over it. In the rainy season, this part of the road is usually very muddy, but the raised roadway that it is intended to construct will make it passable at all times. The length of this section is about 16 miles.

As soon as the road is finished to the coast, it is the intention to utilize one side of it for a trolley line for electric freight and passenger cars. It is estimated that freight can be handled at the rate of 5 cents per ton per mile. Water power is abundant for supplying motive force.—Alfred K. Moe, Consul at Tegucigalpa.

The Osaka Exhibition.*—Consul S. S. Lyon transmits from Kobé, November 13, 1902, clipping from a local paper, which reads in part:

This exhibition will be by far the largest in scope and plan of any ever undertaken by the government, and under the roofs of the fine buildings which are being erected will be amassed the most extensive collection of manufactures and products of the empire ever yet seen. A special feature is the admission of foreign exhibits, it being the desire of the government to do everything possible in order to strengthen the commercial interests and relationship of Japan with other countries.

Two separate areas are to be occupied by the exhibition—one at Tennoji, Osaka, and the other at Sakai; that at the latter place being devoted to the aquarium only. The premises at Osaka occupy 630,000 square feet, while the aquarium is to cover a space of 60,000 square feet. Many more firms than were originally allowed for will exhibit, and all the goods sent will be selected ones only, so that the exhibition will furnish a unique opportunity for those desiring to inspect samples of first-class Japanese manufactures and products. Many of the firms whose spaces have had to be reduced in consequence of the lack of room in the main hall have decided to erect their own buildings, which will form an annex and will be totally different from anything undertaken at similar exhibitions in this country.

Bazars, stalls, and kiosks are to be erected by the several prefectures for the sale of goods produced therein. Foreigners who visit the exhibition will therefore be enabled to make purchases from all parts of Japan and choose innumerable souvenirs which might otherwise necessitate long and expensive railway journeys. The Formosan government will occupy a separate building, in which will be exhibited the products of that island. There will also be a special hall—of Formosan architecture—in which will be given musical entertainments entirely under the direction and management of Formosans.

In the fine-art hall will be found works designed and executed by the leading Japanese artists of the day, which will include paintings, brass work, sculpture, pottery, etc.

Japanese restaurants and tea houses will be placed in various convenient positions. There will be an athletic and recreation ground where Japanese sports in old and present style will be performed daily, with many other entertainments. Dances and music as performed in various centers throughout Japan will be provided; visitors will, if they wish, be enabled to enjoy the novelty which has proved so popular in England and America—"shooting the chute"—a water chute being in course of construction; a big tower is being erected from which visitors will be enabled to obtain a fine view of the city of Osaka; and military and other bands will perform daily and nightly. The exhibition itself will be closed during the evenings, but the grounds are to be brilliantly illuminated by means of electricity, and here most of the entertainments will take place. Various special facilities for seeing the neighborhood are to be offered to holders of exhibition tickets.

Foreign visitors will be well looked after in every way. A hundred and fifty students from the Foreign Language School are to act as guides.

The expense of the exhibition, apart from the cost which is being defrayed by the forty-seven prefectures for their respective exhibits, is estimated at 1,093,973 yen ($540,200). Three million Japanese visitors and a very large number of foreign visitors are expected.

The exhibition, apart from its general interest, will be an event of great national importance, and it bids fair to be a huge success.

Rhenish Lumber Market.—The Rhenish lumber and railroad-tie market depends for orders to a considerable extent on the manufacturers in the industrial regions bordering the River Rhine, and as business in Germany generally has been slack, the Rhenish lumber trade has suffered materially. The large stocks which nearly all dealers had on hand also had an unfavorable influence on the market. Owing to the high prices of wood prevailing about a year ago, the government forest officials placed large quantities of timber on the market—far more than could be disposed of. In February, a heavy windstorm blew down hundreds of thousands of cubic meters of timber in the Vosges and Black Forest. In the neighboring French districts, the storm had done even more damage, so that no sales could be made to these usually regular customers. The government forest officials tried hard to maintain the high prices by placing these enormous quantities of wood on the market gradually and in small lots, but quotations for fir lumber are at present 20 to 30 per cent lower than last year. It is feared that the large dealers will suffer heavy losses in disposing of their stock. An improvement of affairs within the next few months cannot be hoped for.

* See Advance Sheets No. 1283; Consular Reports No. 260.

The hardwood market may be said to be in a more favorable condition, although its fat years have also come to an end. Really good oak continues to be much in demand, and high prices are paid for it. Joiners and manufacturers of railroad cars are more and more demanding first-class material. As much as 80 to 100 marks ($19.04 to $23.80) is frequently paid for a cubic meter of oak. Beech beams find willing purchasers at 13 to 15 marks ($3.09 to $3.57) per cubic meter.—Oliver J. D. Hughes, Consul-General at Coburg.

Bricks in South Africa.—Under date of November 5, 1902, Consul-General W. R. Bigham writes from Cape Town:

Bricks are among the most expensive articles in this city. I am informed that they are sold for £4 1s. 2d. to £5 1s. 2d. ($22.50 to $27.50) per 1,000, and they are so poorly made that they have to be plastered with stucco to keep them from being destroyed by the action of the weather. I have seen some very rough bricks, shipped from England, which are harder than those manufactured here. I have not been able to find out the price, but they are more expensive than those locally made. It seems to me that if some good brick manufacturers close to our coast, in New Jersey or Maryland, would investigate this matter, they would find a large margin for profit. Bricks here are usually 2½ inches thick, 4½ inches wide, and 9 inches long, although I have seen some that are only 2 by 4½ by 9 inches. An American, who uses a great many bricks in building ice plants in this and other cities in this colony, told me he could sell 1,000,000 bricks per week here if he had such hard vitrified bricks as are made in the United States, for these would not have to be plastered. Building is very much retarded on account of the shortage of brick.

Demand for American Superphosphates.—The following has been received from Consul G. H. Jackson, of La Rochelle, under date of November 19, 1902:

The demand for American superphosphates has greatly increased; there have been received at this office letters from several countries, including Germany and Italy, which show that there is an opening here for American enterprise on an extensive scale. I understand from three letters that more than 50,000 tons of superphosphates could be placed at once. In some instances, it would be better to ship the manufactured article direct from the United States. In other instances, it might be well for American capital to establish factories in the countries where phosphates are required, and where the local works have not sufficient capacity to supply the market. Thousands of tons of Belgian fertilizers of this nature are now received at La Rochelle.

Opening for Railway Material in Spain.—One of the most pressing commercial needs of this district is the construction of light railways, to place the fertile fruit and wine districts of the Mediterranean coast in direct communication with the sea.

The "Compañía de Ferrocarriles de Alicante á la Marina" has commenced work on a narrow-gage road, to connect Alicante with Villajoyosa (19 miles), to be prolonged ultimately along the coast to Denia.

The company is exclusively Spanish, but rails and rolling stock will be purchased in the cheapest market. American manufacturers who have offers to make, or who desire particulars of the exact requirements of the road, should address the company direct—Compañía de Ferrocarriles de Alicante á la Marina, 19 Calle Serrano, Madrid.—R. M. Bartleman, Consul at Valencia.

British Railway in Portuguese West Africa.—A cablegram from Consul J. H. Thieriot, of Lisbon, dated December 1, 1902, informs the Department that a concession has been granted to English capitalists to build 1,400 kilometers (870 miles) of railway, from the Lobito Bay district, Benguella, directly east to the Angola frontier. The road is to be constructed within eight years. After twenty years, Portugal will have the right to purchase the line.

INDEX TO ADVANCE SHEETS OF CONSULAR REPORTS.

The Reports marked with an asterisk (*) will be published in the SCIENTIFIC AMERICAN SUPPLEMENT. Interested parties can obtain the other Reports by application to Bureau of Foreign Commerce, Department of State, Washington, D. C., and we suggest immediate application before the supply is exhausted.

TRADE NOTES AND RECIPES.

In a Recent Number of the Druggists' Circular and Chemical Gazette appear some interesting facts on the manufacture of laundry blue. The soluble blue of commerce is much used for laundry work and may, of course, be dispensed dry if desired.

This blue, when properly made, dissolves freely in water, and solutions so made are put up as liquid laundry blue. The water employed in making the solution should be free from mineral substances, especially lime, or precipitation may occur. If rain water or distilled water and a good article of blue be used, a stable preparation ought apparently to result; but whether time alone affects the matter of solubility we are unable to say. As it is essential that the solution should be a perfect one, it is best to filter it through several thicknesses of fine cotton cloth before bottling; or if made in large quantities this method may be modified by allowing it to stand some days to settle, when the top portion can be siphoned off for use, the bottom only requiring filtration.

The soluble blue is said to be potassium ferri-ferrocyanide. If the pharmacist wishes to prepare it himself, instead of buying it ready made, he may do so by gradually adding to a boiling solution of potassium ferricyanide ("red prussiate of potash") an equivalent quantity of hot solution of ferrous sulphate, boiling for two hours and washing the precipitate on a filter until the washings assume a dark-blue color; the moist precipitate can then at once be dissolved by the further addition of a sufficient quantity of water.

About 64 parts of the iron salt is necessary to convert 100 parts of the potassium salt into the blue compound.

Leaf bluing for laundry use may be prepared by coating thick sized paper with soluble blue formed into a paste with a mixture of dextrin mucilage and glycerin. Dissolve a given quantity of dextrin in water enough to make a solution about as dense as ordinary syrup, add about as much glycerin as there was dextrin, rub the blue smooth with a sufficient quantity of this vehicle and coat the sheets with the paint. The amount of blue to be used will depend of course on the intended cost of the product, and the amount of glycerin will require adjustment so as to give a mixture which will not "smear" after the water has dried out and yet remain readily soluble.

Ultramarine is now very generally used as a laundry blue where the insoluble or "bag blue" is desired. It is mixed with glucose, or glucose and dextrin, and pressed into balls or cakes. When glucose alone is used, the product has a tendency, it is said, to become soft on keeping, which tendency may be counteracted by a proper proportion of dextrin. Bicarbonate of sodium is added as a "filler" to cheapen the product, the quantity used and the quality of the ultramarine employed being both regulated by the price at which the product is to sell.

As the mixing and compression process is somewhat troublesome, it may pay better to purchase the balls or cakes from the manufacturer or jobber in large packages and put them up from these into small cartons, as this operation will usually yield much of the profit to be derived from the sale.

Anilin blues are also used, it is said, in laundry work. In an article reprinted in the Circular from the London Laundry Record, it was said: "The coal tar blues are not offered to the general public as laundry blues, but laundry proprietors have them frequently brought under their notice, chiefly in the form of solutions, usually 1 to 1½ per cent strong. These dyes are strong bluing materials, and, being in the form of solution, are not liable to speck the clothes. Naturally their properties depend upon the particular dye used; some are fast to acids and alkalies, others are fast to one but not to another; some will not stand ironing, while others, again, are not affected by the operation; generally they are not fast to light, but this is only of minor importance. The soluble, or cotton blues, are those most favored; these are made in a great variety of tints, varying from a reddish-blue to a pure blue in hue, distinguished by such brands as 3R, 6B, etc. Occasionally the methyl violets are used, especially the blue tints. Blackley blue is very largely used for this purpose, being rather faster than the soluble blues. It may be mentioned that a 1 per cent solution of this dye is usually strong enough. Unless care is taken in dissolving these dyes they are apt to produce specks, which is not desirable."

It was stated in the article referred to that the heat to which the pure blues are exposed in ironing the clothes causes some kinds to assume a purple tinge.

The cheapest anilin blue costs, say, roughly, three times as much as "soluble blue," yet the tinctorial power of the anilin colors is so great that possibly they might afford a solution of the cheapening question.

Metals in the Household, Etc.—Prof. Lehmann has reported on the significance of the hygienically important metals, aluminium, lead, copper, nickel, tin and zinc, in the household and in the food branches, at the meeting of the German Verein fuer oeffentliche Gesundheitspflege. Actually injurious and dangerous are lead and all lead preparations. Mercury poisoning in the household is too rare to deserve any mention. The poisonousness of copper, zinc and tin is very slight and greatly exaggerated by some authors. Silver, aluminium, iron and nickel may be called entirely harmless. Despite the slight hygienic value of all heavy metals, excepting lead and quicksilver, all endeavors to keep these metals away from our aliments, especially preserves, should be assisted.—Neueste Erfindungen und Erfahrungen.

Aquafortis for the Touch Stone.—The following are the two compositions most in use:

Nitric acid	30 parts
Hydrochloric acid	3 parts
Distilled water	20 parts

Or

Nitric acid	980 grammes
Hydrochloric acid	20 grammes

The latter composition is that indicated by Cahours in his Leçons de Chimie; the nitric acid must have a density of 1.34.—Journal Suisse d'Horlogerie.

THE

Scientific American Supplement.

PUBLISHED WEEKLY.

Terms of Subscription, $5 a Year.

Sent by mail, postage prepaid, to subscribers in any part of the United States or Canada. Six dollars a year, sent, prepaid, to any foreign country.

All the back numbers of THE SUPPLEMENT, from the commencement, January 1, 1876, can be had. Price, 10 cents each.

All the back volumes of THE SUPPLEMENT can likewise be supplied. Two volumes are issued yearly. Price of each volume, $2.50 stitched in paper, or $3.50 bound in stiff covers.

COMBINED RATES.—One copy of SCIENTIFIC AMERICAN and one copy of SCIENTIFIC AMERICAN SUPPLEMENT, one year, postpaid, $7.00.

A liberal discount to booksellers, news agents and canvassers.

MUNN & CO., Publishers, 361 Broadway, New York.

TABLE OF CONTENTS.